Why U.S. Buys Missiles Abroad

page 38

electronics

A McGRAW-HILL PUBLICATION JANUARY 15, 1960 PRICE SEVENTY-FIVE CENTS

Maser Probes Outer Space

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Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 1, No. 8

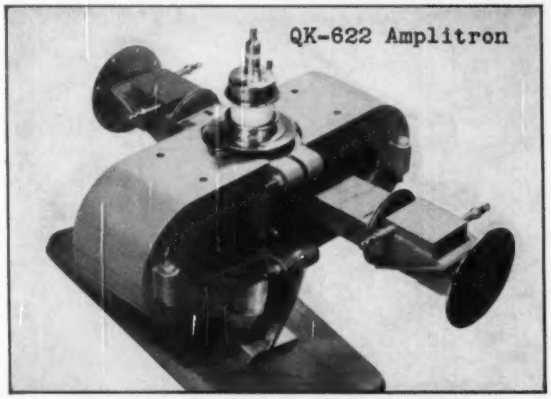
NEW RAYTHEON HEATERLESS AMPLITRONS EXCEED 1,000 HOURS AT RATED POWER OUTPUT

Two new 3-megawatt, S-band Amplitrons have demonstrated an operating life of more than 1,000 hours at rated power output. The QK-622 covers the 2,900 to 3,100 Mc band; the QK-783, the 2,700 to 2,900 Mc band. Both tubes supply full power with low phase pushing characteristics over their entire operating bands at efficiencies greater than 70%--making them unquestionably the most highly efficient microwave tubes thus far developed.

Tubes may be operated at reduced peak power levels to serve as driver stages. High efficiencies are retained at peak power of 600 Kw and gain of 10 db.

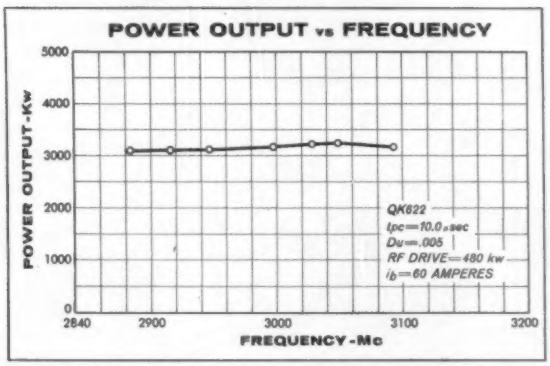
Exceptionally long tube life is made possible by the fact that no cathode warmup is required. Starting takes place whenever RF input is present prior to application of modulating pulse. Heater supplies may be omitted entirely from the equipment.

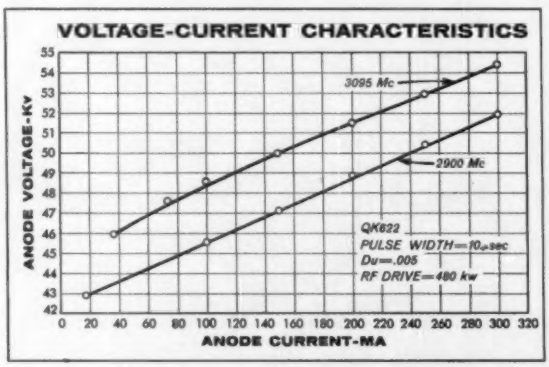
Applications include power-amplifier stages for long-range radars. The tube has been used successfully as an RF power source for linear accelerators.



Typical Operating Characteristics
(QK622 and QK783 Amplitrons)

Peak Power Output (min.)	3 Mw
Average Power Output	15 Kw
Pulse Duration	10 μ sec
Band Width	200 Mc
Duty Cycle	.005
Pulse Voltage	50-55 Kv
Peak Anode Current	65 amps
Efficiency	70%
RF Input	475 Kw
Weight (with permanent magnet)	125 lbs.





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electronics

JANUARY 15, 1960

A McGRAW-HILL PUBLICATION
Vol. 33 No. 3

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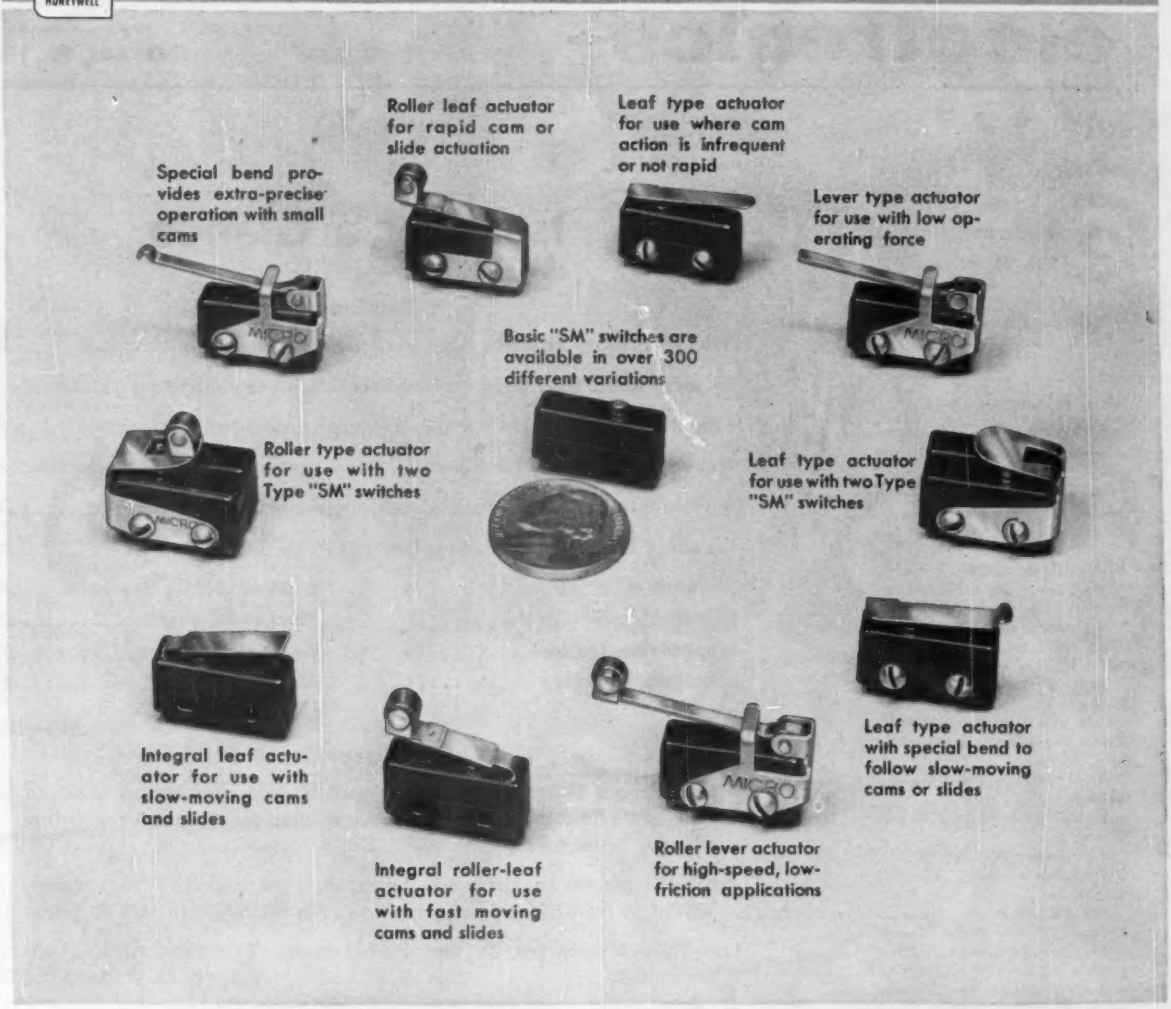
MICRO SWITCH Precision Switches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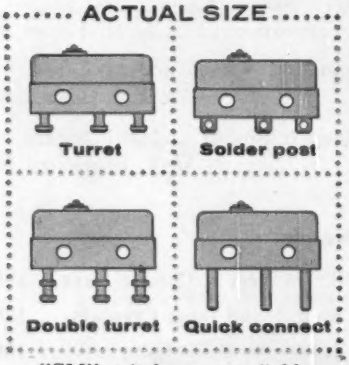
Leaf type actuator with special bend to follow slow-moving cams or slides

Ten different ways to actuate this small, dependable switch



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Here are ten "SM" subminiature switches equipped with ten different integral and auxiliary actuators that contribute to the great versatility of these dependable, small switches. For ten years MICRO SWITCH subminiature switches have been the choice of designers who require switches of high electrical capacity which can be mounted in small space.

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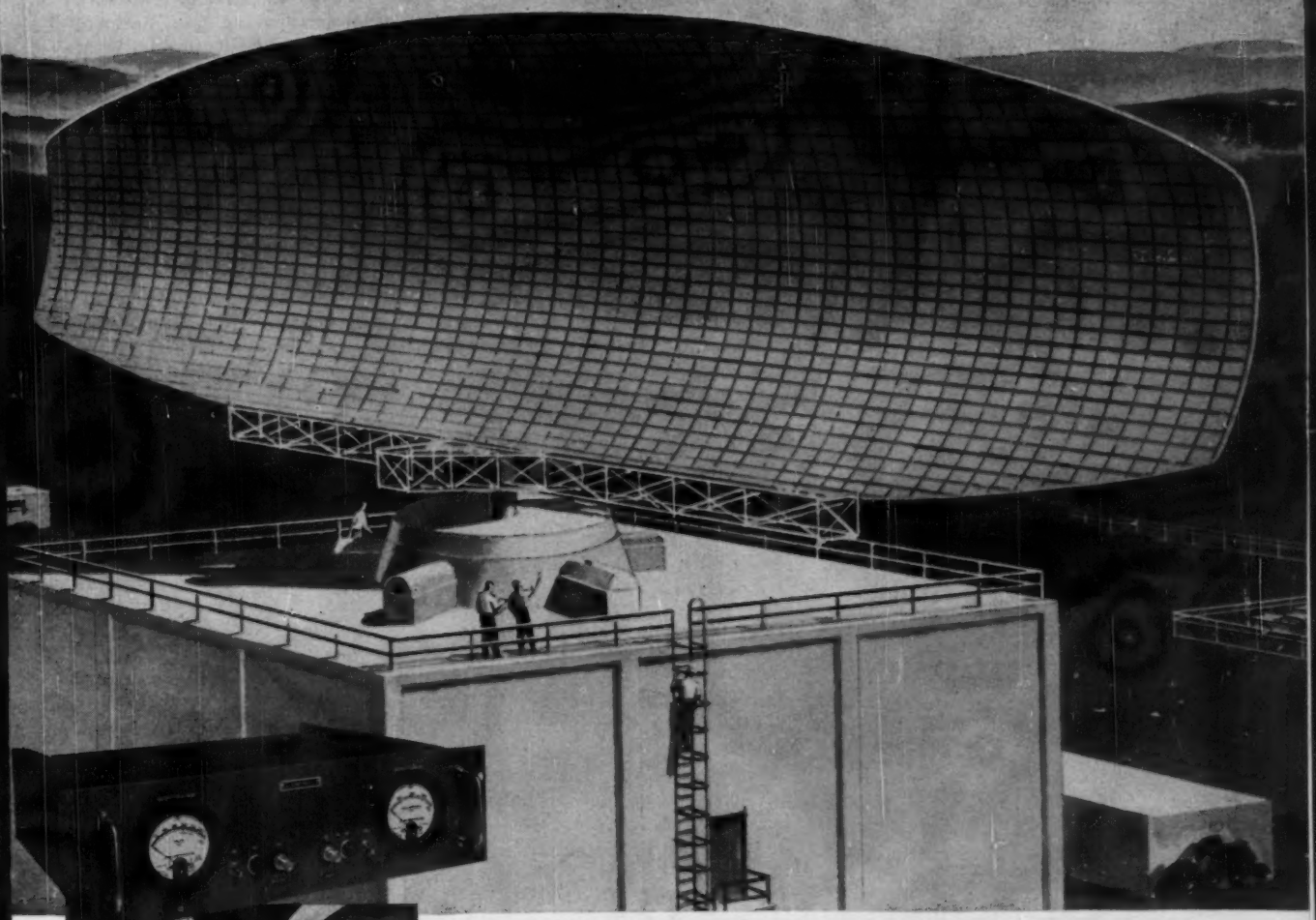

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SHOPTALK . . . editorial

FOREIGN COMPETITION. Increasing competition for leadership in electronics, from beyond the borders of the U.S., is a fact of our engineering and business life today.

• Japanese transistor imports are still under fire, but this week the fire is being returned. Rising-Sun trade associations have filed a sharp rebuttal to claims that the import level is endangering U.S. national defense. Washington sources indicate the unlikelihood of additional import curbs at this time.

• Canadian broadcasters are showing a keen interest in stereophonic radio. Without benefit of complex committees, a Montreal station will soon be on the air with a-m/a-m stereo for about two hours a day. Plans are afoot to make a-m stereo receivers available in the near future. Meanwhile, listeners will most likely use two separate sets placed six or eight feet apart.

• European missilemakers may become prime suppliers of short-range antitank wire-guided missiles for the U. S. Army and Marines. This would represent a high-production business amounting to tens of millions of dollars a year. We are currently buying a few French and German antitank missiles for evaluation.

Growing concern of U. S. manufacturers regarding foreign competition can be healthy. Keys to the future include improvement in product quality, reduction of engineering costs and elegant simplicity rather than complexity of design.

W W MacDonald

EDITOR

Coming In Our January 22 Issue

CRYOGENICS. Research into the behavior of materials at low temperatures is gathering momentum as more and more uses for cryogenic devices arise. One area is the application to computers. Devices such as the superconducting cryotron (ELECTRONICS, p 39, April 17, 1959) give promise of increased speed and diminished size for digital computers.

Properties of materials near absolute zero pose special problems in circuit testing. Measurement of the critical current in superconducting contacts requires test equipment with fast response because of the short periods such currents can be maintained. In our next issue, J. I. Pankove and R. Drake of RCA Laboratories in Princeton, N. J. describe a system with the necessary response time for measuring currents at 4.2 K.

The tester was developed for a program of basic and applied research in cryogenics, with which Pankove and Drake have been associated during the past year. Pankove is responsible for several new cryogenic device concepts, Drake has an extensive background in test equipment design. Prior to working in cryogenics, Pankove was active in solid-state electronics, for which he received two research awards. He holds 25 issued patents.

RADIATION MONITOR. Nuclear-powered ships require special monitoring equipment to protect their personnel from radioactive dust. Next week, H. E. Debolt of Fairchild Camera and Instruments in Syosset, N. Y. describes a transistorized monitor that sounds an alarm when alpha and beta radiation reach a preset level. Monitor consists of a scintillation counter which feeds pulses to a computer-indicator. Computer determines the pulse rate, which is directly proportional to radioactivity.

SPRAGUE® RELIABILITY in these two dependable wirewound resistors

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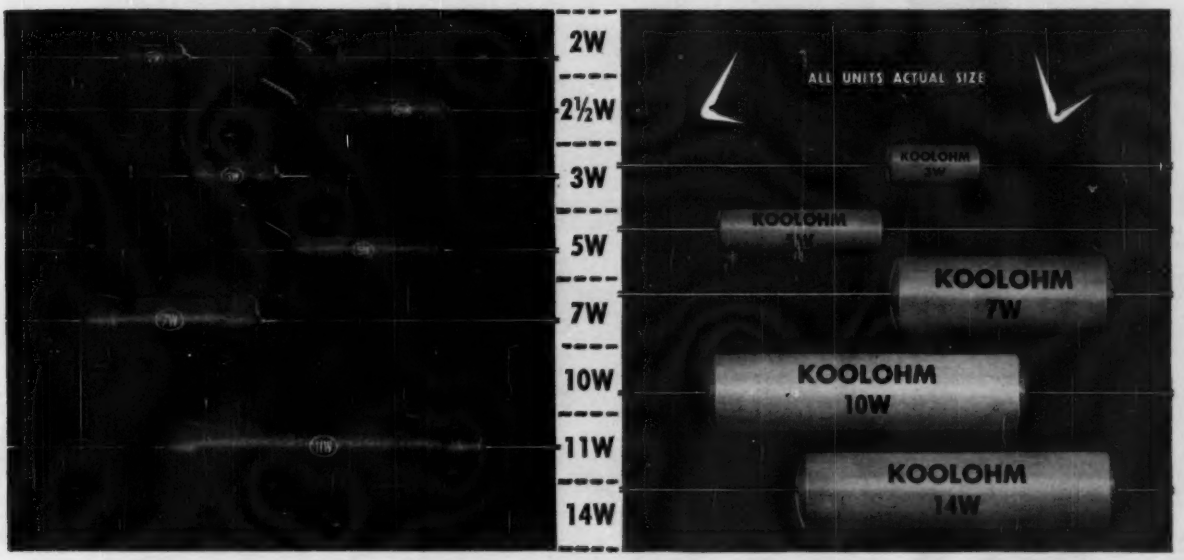
You can depend upon them to carry maximum rated load for any given physical size.

Send for Engineering Bulletin 7300 for complete technical data.



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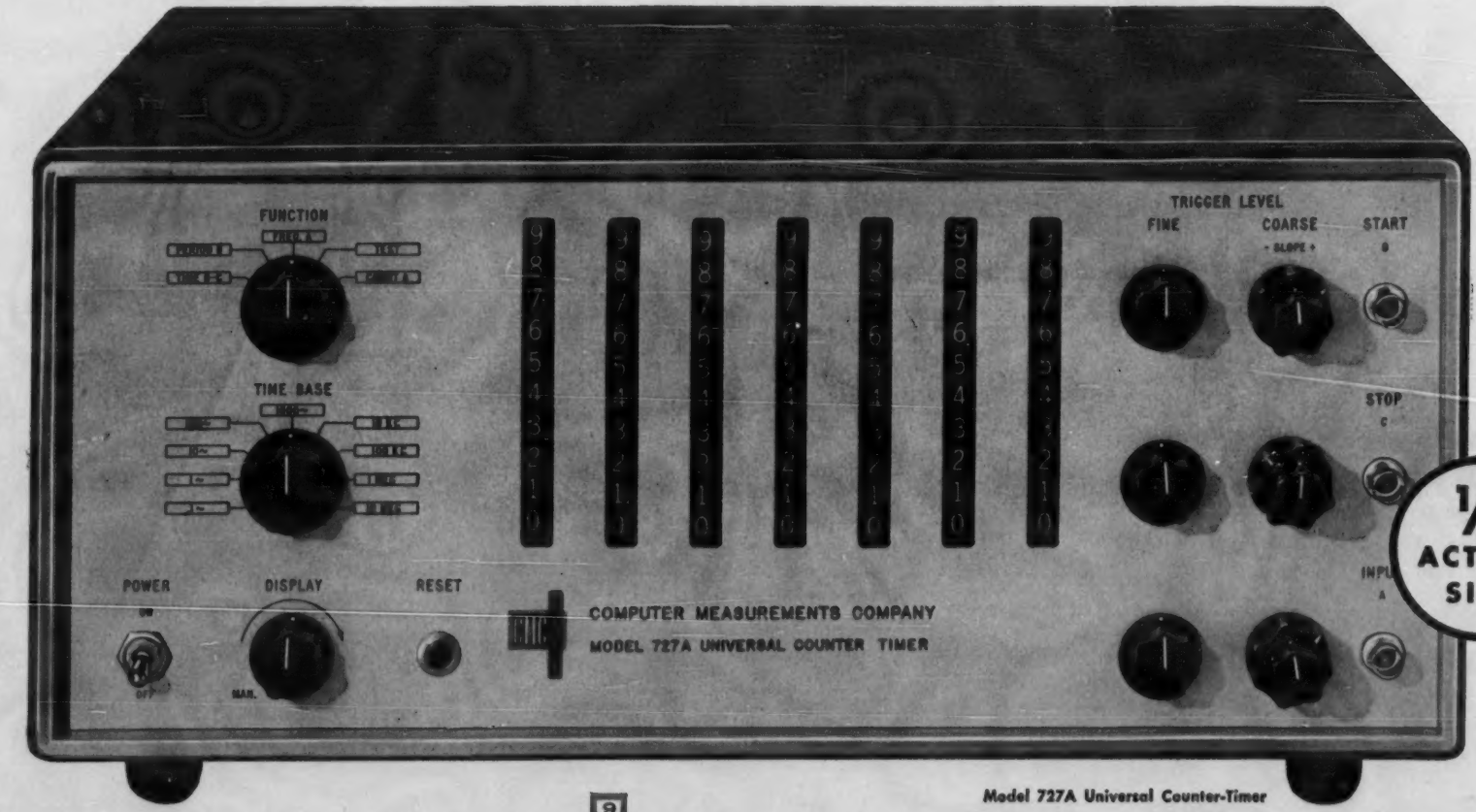

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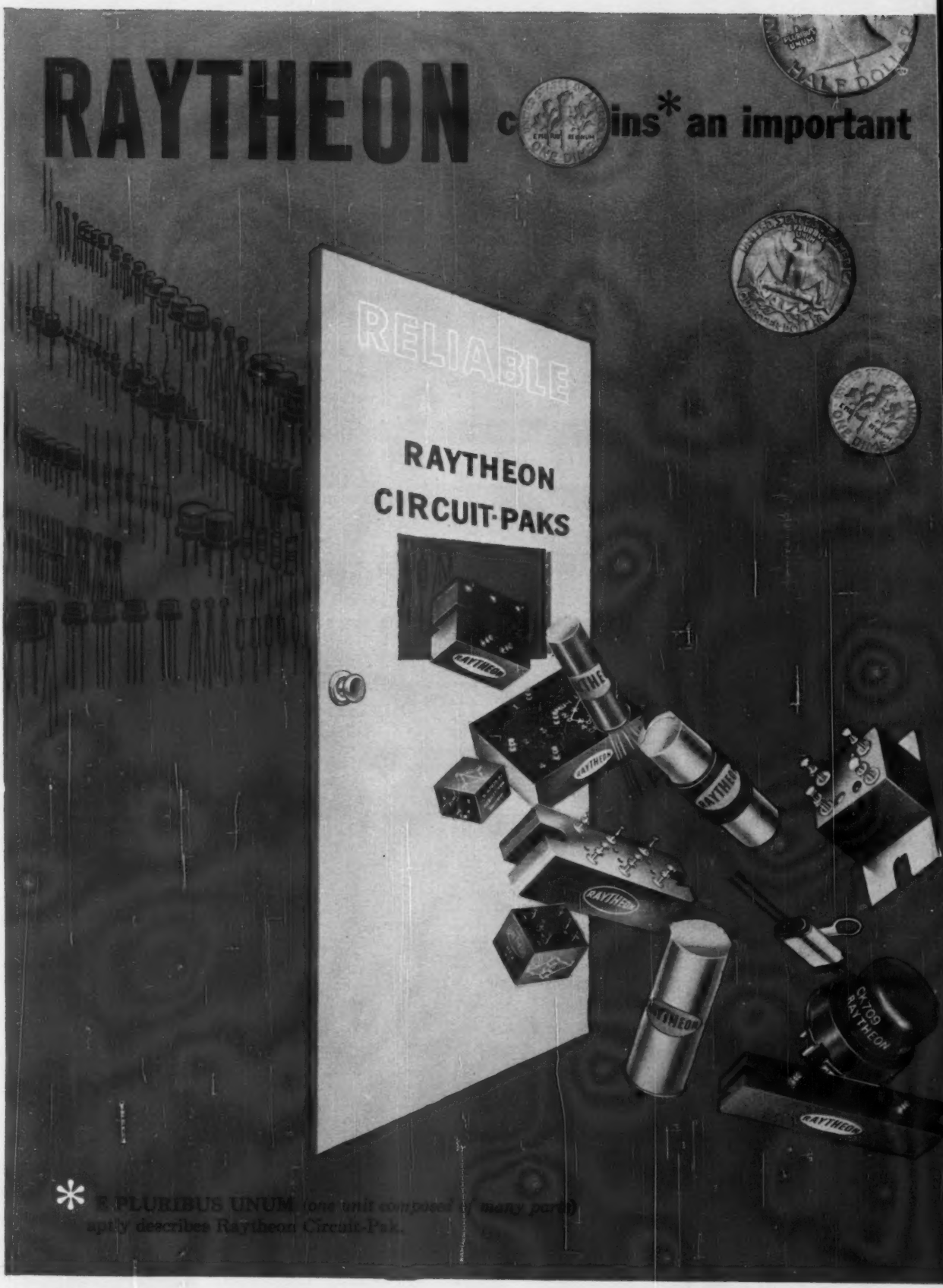

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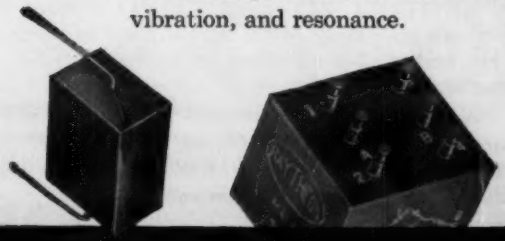

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URGENT PROBLEMS RELIABLY SOLVED

ELECTRONICS NEWSLETTER

THERMOPLASTIC RECORDING development at GE has progressed beyond the implications of a technical article written more than a year ago and published in December by the *Journal of Applied Physics*. The article described a permanent recording device giving black-and-white and simultaneous color. Last week ELECTRONICS learned that a new tube has been developed for the system. The tube can be used interchangeably for permanent recording of black-and-white and simultaneous color. Instead of using a gun with a splitter grid to produce the phase diffraction gratings on the thermoplastic surface, inventor W. E. Glenn discloses that the new tube produces the gratings by velocity modulation of the horizontal sweep with low-amplitude r-f carriers. Glenn also reports that, in terms of information storage capacity, the GE thermoplastic tape is "several hundred times denser than the best available magnetic tape," is also "comparable to highest resolution photographic film." For more on thermoplastic recording, see p 46.

New Amperex magnetron which operates at 25 kw peak power at 35-kmc and provides a 0.02 millimicro-second pulse width is now operating in a Philips airport surface detection radar set. The radar can distinguish between objects four yards apart at a distance of 1,000 yards.

FEDERAL COMMUNICATIONS COMMISSION, in yearend statement marking its 25th year of operation, reported 570,000 radio station licenses using more than 1.7 million transmitters. F-m authorizations climbed from 690 to 825, with some 665 stations on the air compared with 570 a year ago. A-m gained about 100 authorizations and 150 operating stations during the year, bringing the 1959 figures to about 3,500 and 3,450 respectively. Tv station figures did not change materially—672 hold authorizations and more than 500 in operation (including 76 uhf).

SOLID-STATE COMBUSTION CONTROL system will be installed on a 2-zone slab heating furnace at the plant of an eastern steel producer in mid-1960. The system, to be supplied by Hagan Chemicals & Controls, Inc., Pittsburgh, will use magnetic amplifiers, and includes controls for zone temperature, zone fuel/air ratio, furnace pressure, recuperator temperature balance and air pressure, along with panels and recording instruments.

All-weather radiometric sextant, miniaturized for submarine installation and some five times as accurate as many marine compasses now in use, will be designed by AC Spark Plug under a Navy BuShips contract.

RADIOPHONOGRAPH which weighs 2.8 lb. and operates as a 540 to 1,600-kc radio set with its lid on, and as a phonograph with its lid off, has just been introduced in Japan by Standard Wireless Industry. The company expects to produce 10,000 units per month by April for export. Japanese yen price is equivalent to $42. The unit uses four dry batteries, seven transistors, two diodes and a thermistor.

Antisubmarine warfare (ASW) program demands more and more electronic gear. A $4 million Navy contract was recently awarded to Hazeltine for 32,000 sonobuoys and repair kits. Company is currently producing 12,000 of the cylindrical air-launched packages that detect and transmit sub noises.

AIRBORNE EARLY WARNING blimps just delivered to the Navy by Goodyear Aircraft will carry what the company describes as "the largest complex of modern radar and electronic equipment to be operational in a single aircraft." The 400-ft. 1½ million cu ft non-rigid airships designated the ZPG-3W will perform patrol duty as part of the North American Air Defense Command. Two blimps have been delivered; two others are being built. Goodyear says a transistorized intercommunications system with pushbuttons and flashing call lights aids crew teamwork. System includes an ecm radio control unit and a loudspeaker radio monitor control unit, which permits the selection of any one of 13 audio outputs to be monitored over the local loudspeaker.

SOVIET AUTOMATIC CONTROL SYSTEM checks the dimensions of mass-produced parts by using a cathode-ray-tube to scan the contours of the part under test and of a mask fixing the allowable tolerances. A coarse scanning pattern is traced out on the crt screen using a horizontal deflection frequency of 1 cycle and a vertical deflection frequency of 50 cycles. Two thin lines on a transparent mask attached to the screen represent the upper and lower limits of the parts being checked. The production control device is described in the Soviet journal "Priborostroienie," No. 7, 1959.

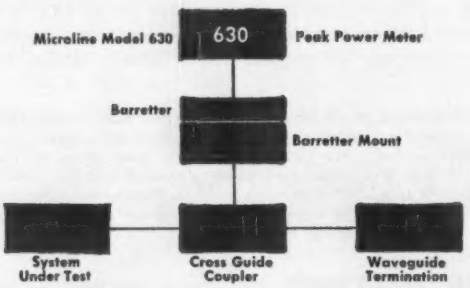
Japanese yearend tv set buyers so swamped the market that manufacturers couldn't get enough glass tube envelopes as 1959 ended. Six set makers are now turning out 500,000 sets a month. December demand was estimated at 430,000 sets; 300,000 were sold in November. Buying rush is attributed to extension of the government tv network to many outlying areas.

BRITISH TELEVISION and radio manufacturers had a bumper year in 1959, and all sales records have been smashed, according to estimates of the authoritative *Financial Times*. Tv receiver output was estimated at 2.8 million, 800,000 above 1958, with retail sales totaling some $462 million. More than 1.6 million radios were estimated to have been produced and sold in '59. Growing interest was noted in stereo equipment.

NOW—simple, accurate, direct PEAK POWER

PEAK POWER may now be measured directly—with speed and simplicity—using integrated Microline® equipment from Sperry. Unlike other power measurement techniques which require a wattmeter bridge or calorimetric load, plus an oscilloscope and synchroscope—just four additional components are necessary when using the Microline Model 630: a crossguide coupler, a termination, a barretter mount, and a barretter.

DIRECT READING—Pulsed microwave energy is coupled from the system under test into the crossguide directional coupler, and a high power termination connected to the coupler's primary output. The suitably attenuated energy is fed from the secondary arm directly into a waveguide barretter mount. The output from the barretter and barretter mount is fed coaxially to the input of the Microline Model 630, and peak power is read directly from the scale. The measurement is simple, positive and precise.



THE "630" METER consists of an active differentiator, video amplifier, peak reading voltmeter, and a calibration circuit which eliminates calibration down-time.

THE BARRETTER, in a suitable mount, is subjected to pulses of microwave energy from the system under test. The barretter is operated in a constant current circuit and its resistance change is a function of temperature, which is determined by total power. The voltage waveform out of the barretter mount will be sawtooth with an essentially linear rise when a pulse is applied and an exponential decay as a resistance of the barretter returns toward normal after the pulse has decayed. The slope of the waveform is a function of peak power. The sawtooth waveform out of the barretter mount is fed into the differentiator, the output of which is a video pulse. This pulse is an accurate replica of the envelope of the microwave pulse impinging on the barretter. The amplitude of the video pulse is proportional to microwave peak power.

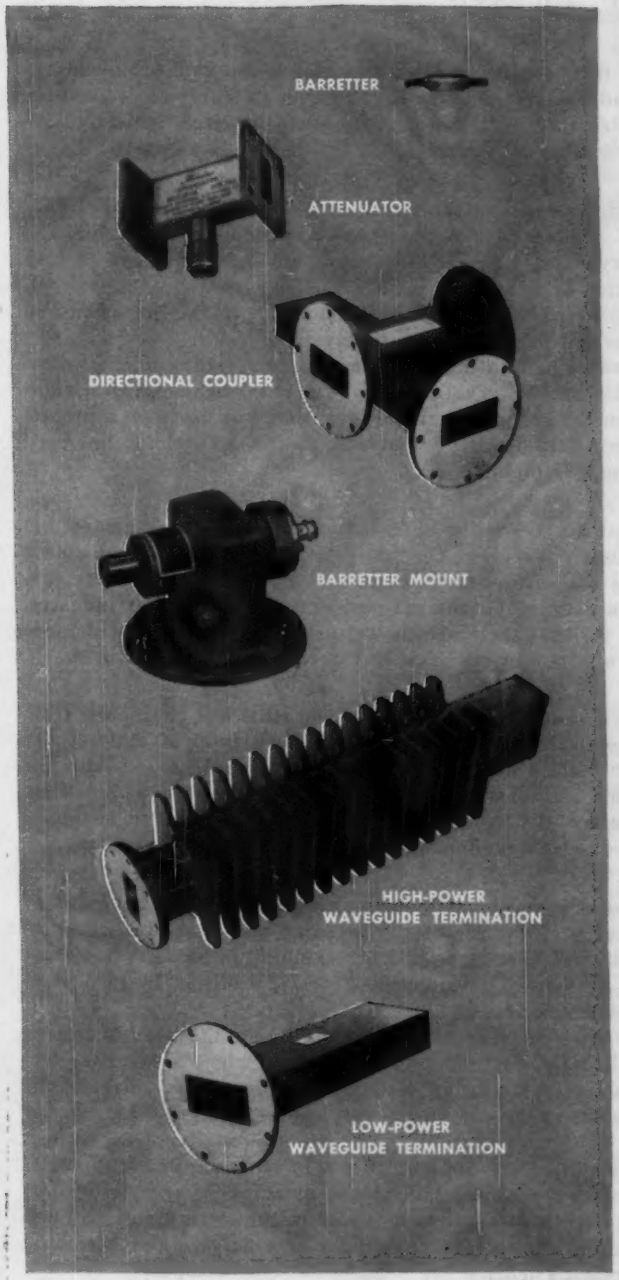
DIFFERENTIATOR OUTPUT is amplified in the video amplifier to provide sufficient signal amplitude to properly operate a peak reading voltmeter circuit. A portion of the output of the video amplifier is brought out to a front panel jack to provide a connection for viewing the video pulse with an external oscilloscope, if desired.

THE PEAK READING VOLTMETER utilizes a novel amplifier feedback circuit which provides a stable and accurate means of measuring the peak voltage of a video pulse over a considerable range of pulse width and repetition rates. The output of the peak voltmeter circuit is a front panel meter which has been calibrated in milliwatts.

Address inquiries to Manufacturers' Representatives: Gerald B. Miller Co., P. O. Box 1471, Hollywood 28, California; Louis A. Garten & Associates, 645 Eagle Rock Ave., West Orange, New Jersey; Technical Instruments, Inc., 90 Main St., Reading, Mass.

SPERRY MICROWAVE ELECTRONICS COMPANY,

MEASUREMENTS



BARRETTERS

Model	Nominal Resistance (ohms)	Price
825	200 for Peak Power Measurements	$ 14.
823	200 for Peak Power Measurements	14.

ATTENUATORS

Model	Description	Frequency Range-kmc	Attenuation Range-db	Waveguide Size	Fittings	Price
134	Calibrated ± .5db	8.5-9.6	2-45	1"x½"	UG-39/U	$220.
152A	Variable	8.1-12.4	0.5-20	1"x½"	UG-39/U	45.
375A	Variable	12.4-18.0	1-15	0.702"x0.391"	UG-419/U	75.
374A	Variable	26.5-40	1-20	0.360"x0.220"	UG-599/U	60.

DIRECTIONAL COUPLERS

Model	Description	Frequency Range	Attenuation-db	Fittings	Price
517	⅞" Coaxial	.240-.480	30	UG-46/U*	$150.
519	⅞" Coaxial	.480-.960	30	UG-46/U*	150.
467	⅞" Coaxial	1.99-4.0	20-30-40	UG-46/U*	150.
306	3"x1½" Waveguide	2.6-4.0	30	UG-214/U	100.
544	3"x1½" Waveguide	2.6-4.0	40	UG-214/U	150.
545	3"x1½" Waveguide	2.6-4.0	50	UG-214/U	150.
233	2"x1" Waveguide	4.0-6.0	24	UG-149A/U	85.
321	2"x1" Waveguide	4.0-6.0	30	UG-149A/U	125.
322	2"x1" Waveguide	4.0-6.0	40	UG-149A/U	125.
209	1½"x¾" Waveguide	5.3-8.1	24	UG-344/U	75.
237	1½"x¾" Waveguide	5.3-8.1	30	UG-344/U	85.
546	1¼"x⅝" Waveguide	7-10	30	UG-51/U	85.
547	1¼"x⅝" Waveguide	7-10	40	UG-51/U	85.
235	1"x1½" Waveguide	8.1-12.4	20	UG-39/U	65.
419	1"x½" Waveguide	8.1-12.4	30	UG-39/U	65.
234	1"x½" Waveguide	8.1-12.4	40	UG-39/U	65.
368	0.702"x0.390" Waveguide	12.4-17.0	20	UG-419/U	65.
413A	½"x¼" Waveguide	18.0-26.5	20	UG-595/U	65.
414A	½"x¼" Waveguide	18.0-26.5	30	UG-595/U	65.
405A	0.360"x0.220" Waveguide	26.5-36.0	20	UG-599/U	80.
429A	0.360"x0.220" Waveguide	26.5-40.0	10	UG-599/U	85.

*Input fitting. Main line output UG-45/U. Secondary line output, UG-46/U. Adapters (Models 352A and 217) convert these units to Type N.

BARRETTER MOUNTS

Model	Line Size	Barretter Type*	Frequency Range-kmc	Max. VSWR	Fittings Input	Fittings Output	Price
554	⅞" Coax.	811B/550T	.82-2.0	1.8/1.5	UG-46/U	BNC	$175.
245	2"x1"	821B	3.7-4.5	1.5	UG-149A/U	UHF	35.
184	1"x½"	821B	8.5-9.6	1.5	UG-39/U	UHF	70.
423A	2"x1"	543T	5.0-5.9	1.5	UG-149/U	BNC	135.
219C	1"x½"	—T	8.5-9.6	1.5	UG-39/U	BNC	130.

*B-Barretter, T-Thermistor

HIGH-POWER WAVEGUIDE TERMINATIONS

Model	Size	Frequency (kmc)	Power Capacity Av. (w)	Power Capacity Peak (kw)	Max. VSWR	Fittings	Price
563	3"x½"	2.6-4.0	2200	2200	1.15	UG-584/U	$150.
564	2"x1"	3.95-6.0	1500	1500	1.15	UG-407/U	140.
565	1¼"x⅝"	7.0-10.0	350	350	1.15	UG-138/U	100.
566	1"x½"	8.1-12.4	300	300	1.15	UG-135/U	85.

LOW-POWER WAVEGUIDE TERMINATIONS

Model	Size	Frequency Range-kmc	Power Capacity	Max. VSWR	Fittings	Price
308	3"x1½"	2.6-4.0	1	1.04	UG-214/U	$ 40.
370	0.702"x0.391"	12.4-18.0	0.5	1.05	UG-419/U	25.
418A	½"x¼"	18.0-26.5	0.5	1.07	UG-595/U	30.
369A	0.360"x0.220"	26.5-40.0	0.5	1.10	UG-599/U	35.
637	⅞" Coaxial	.65-3.5	12	1.4	UG-46/U	55.

SPERRY

CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION

WEINSCHEL

FIXED COAXIAL ATTENUATORS

1 to 12.4 KMC

50 Ohms 1 to 20 db

Connectors: Type N, C, BNC, TNC or SC. Each type with male/female, double male or double female connectors. Made with Weinschel Film Resistors for maximum stability.

Model 210 Type N Connectors
Model 520 Type C Connectors
Model 540 Type BNC Connectors
Model 633 Type TNC Connectors
Model 663 Type SC Connectors

WE CO

Write for complete catalog, specifying frequency range of interest.

Weinschel Engineering

KENSINGTON, MARYLAND

WASHINGTON OUTLOOK

TWO ELECTRONICS CONTRACTORS for NASA have reported patentable inventions on agency projects: Northrop Corp.'s Nortronics div., Hawthorne, Cal., which has developed a new hypersonic flow direction sensor, and Aero-Geo-Astro Corp., Alexandria, Va., a radar tracking beacon.

In recent months, NASA's patent policies have become the center of a new Congressional ruckus. The Nortronics case demonstrates the difference between NASA and Defense Dept. patent policies and plays up what's at issue in the controversy.

Under military R&D contracts, the contractor keeps title to any invention developed and has the right to royalties on commercial production. The military contracting agency gets only a royalty-free, non-exclusive license to use the invention.

NASA's policy falls between the Pentagon's liberal system and AEC's restrictive patent scheme, under which the agency acquires rights and interests in all inventions of its contractors. NASA is required to take title to the invention or waive all rights.

In the Aero-Geo-Astro case, NASA has taken title to the invention and the contractor has not petitioned for a waiver.

Nortronics, however, is fighting for its own patent rights on the hypersonic flow direction sensor. The company has challenged NASA's right to the invention on the grounds that the invention was made on a project which began under a Defense Dept. contract. So far, no decision has been made on the company's claim.

● **Over the past six years** the split between federal government and private industry shares of the nation's research and development expenditures has shifted from 60 percent industry—40 percent government to a ratio of 60 percent government—40 percent industry.

The shift in R&D spending shows up in a new National Science Foundation analysis of research and development expenditures.

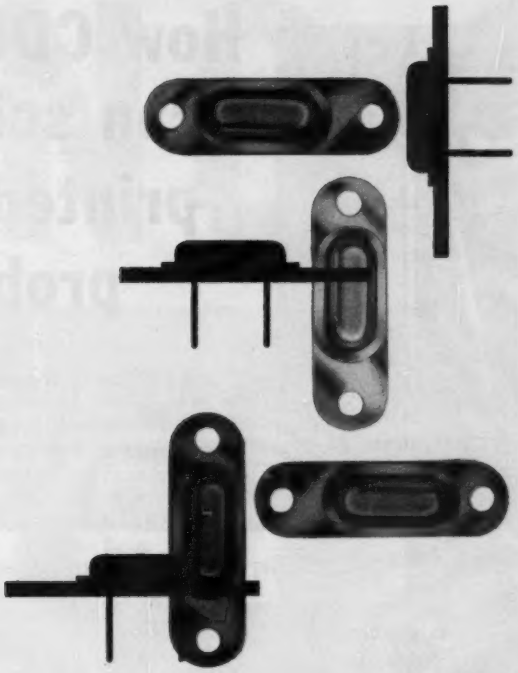
NSF reports that total U.S. spending on R&D has burgeoned from an annual total of $5.1 billion in 1953-54 to a total of at least $12 billion in 1959-60. During the period, the federal government has almost tripled its R&D budget—from $2.7 billion to $7.7 billion. Industry, meanwhile, has doubled the amount of its own money it spends to sponsor R&D efforts—from $2.2 billion to $4.4 billion.

However, the government is turning more and more to industry for the actual performance of the research and development work. In the past six years, the rate of R&D spending in industry facilities has zoomed by almost 160 percent—from $3.6 billion in 1953-54 to an estimated $9.4 billion in 1950-60.

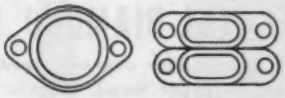
Although the NSF report fails to detail how these expenditures are being allocated by industry, government experts say the electronics industry is taking on a dominant role in the performance of both industry-sponsored and government-supported R&D.

● **The big news** about Defense Dept. efforts in computer application has usually been the use of special-purpose machines geared to weapon systems and supporting apparatus. But in the more mundane business of supply management, the military services are also becoming an ever-increasing market for commercial-type computers.

Latest figures show the services using 170 business-type computers for supply management functions. The Pentagon's rental bill will run to $111 million this year, compared to $82 million in fiscal 1959, and the outlook is for continuing increases.



CLEVITE'S NEW
SPACESAVER
TRANSISTOR



½ *actual size*

THREE AMPERE SWITCHING TYPES

TEST	CTP 1728	CTP 1735	CTP 1729	CTP 1730	CTP 1731	CTP 1736	CTP 1737	CTP 1733
Min BVcbo @ 2 ma (volts)	40	60	80	100	40	60	80	100
Min BVceo @ 500 ma (volts)	25	40	55	65	25	40	55	65
Min BVces @ 300 ma (volts)	35	50	65	75	35	50	65	75
Max Icbo @ 90°C @ Max Vcb (ma)	10	10	10	10	10	10	10	10
Max Icbo @ 2 V (μa)	50	50	50	50	50	50	50	50
D. C. Current Gain @ 0.5A	30-75	30-75	30-75	30-75	60-150	60-150	60-150	60-150
Max Veb @ 3.0 A (volts)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Max Vce (sat) @ 3.0A, 300 ma (volts)	1.0	1.0	1.0	1.0	0.8	0.8	0.8	0.8
Min fae @ 3.0 A (kc)	20	20	20	20	15	15	15	15
Max Thermal Resistance (°c/w)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Compared with present power transistors of similar ratings, the new Clevite ***Spacesaver*** gives you important new advantages.

Better Switching — Its low base resistance gives lower input impedance for the same power gain and lower saturation resistance, resulting in lower "switched on" voltage drop. Its lower cut off current means better temperature stability in direct coupled circuits (such as regulated power supplies) and a higher "switched off" impedance.

Better Amplifying — Improved frequency response leads to higher audio fidelity, faster switching and improved performance in regulated power supply applications.

Better Mounting — The ***Spacesaver's*** simple rectangular configuration and low silhouette make it adaptable to a wide variety of mounting requirements where space is at a premium. In aircraft and missile applications, its low mass (half present type) improves shock and vibration resistance of lightweight assemblies.

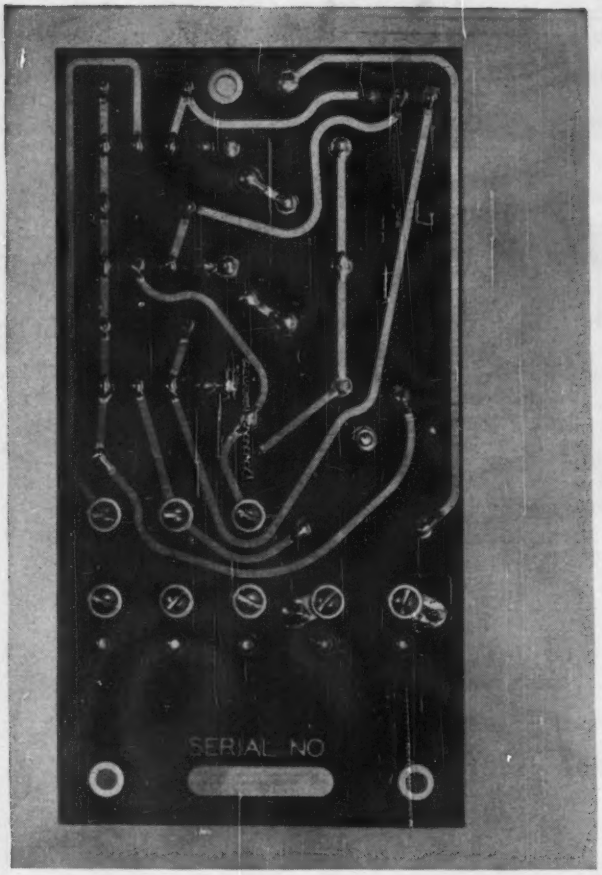
A DIVISION OF CLEVITE CORPORATION

Phone for data and prices.

CLEVITE TRANSISTOR

254 Crescent Street Waltham 54, Mass. Tel: TWinbrook 4-9330

CIRCLE 15 ON READER SERVICE CARD



High strength-to-weight ratio. This printed wiring board for a phase failure relay (manufactured by Phase-Guard Co., Carnegie, Pa., and distributed by Stradley Engineering Co., Pittsburgh) was designed with CDF Di-Clad 28E (epoxy resin laminated with medium weave glass cloth) for high mechanical strength, very low moisture-absorption, and good insulation resistance. Details upon request.

How CDF Di-Clad* can solve your printed-circuit problems

The CDF line of copper-clad laminates in all grades is now known by a new name—Di-Clad. Di-Clad grades meet the varying needs of design, production, and operation of electronic equipment. Grades other than those described are also available.

Di-Clad 2350. An economy paper-base phenolic grade having good tensile, flexural, compressive, and impact strength. Adequate for most non-critical printed circuit applications. Can be cold punched and sheared up to 5/64 of an inch in thickness.

Di-Clad 112T. A Teflon* glass-fabric laminate offering the best dielectric properties over a wide temperature and frequency range.

Send us your requirements and let our engineers help you select the right grade for your application.

*Du Pont trademark for its tetrafluoroethylene resin.

CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Bakelite COMPANY • NEWARK 16, DEL.

In Canada: 46 Hollinger Road, Toronto 16, Ont.

TYPICAL Di-Clad PROPERTY VALUES

	Di-Clad 2350	Di-Clad 26 (NEMA XXXP)	Di-Clad 28 (NEMA XXXP)	Di-Clad 28E (NEMA G-10)	Di-Clad 112T Teflon*
BOND STRENGTH—0.0014" foil (lbs. reqd. to separate 1" width of foil from laminate)	6 to 10	6 to 10	6 to 10	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (Deg. C.)	120	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil for 1/16" thickness)	800	900	850	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90% RH (ASTM D257, Fig. 3)	500	150,000	600,000	100,000	75,000
DIELECTRIC CONSTANT 10^6 Cycles	4.5	4.0	3.6	4.9	2.6
DISSIPATION FACTOR 10^6 Cycles	0.040	0.026	0.027	0.019	0.0015
ARC-RESISTANCE (Seconds)	5	10	10	130	180
TENSILE STRENGTH (psi.)	18,000	16,000	12,000	48,000	23,000
FLEXURAL STRENGTH (psi.)	27,000	21,000	18,000	70,000	13,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.80	0.45	0.42	12.0	6.0
COMPRESSIVE STRENGTH flatwise (psi.)	32,000	28,000	25,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Paper	Paper	Paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural	Natural greenish	Natural	Natural	Natural

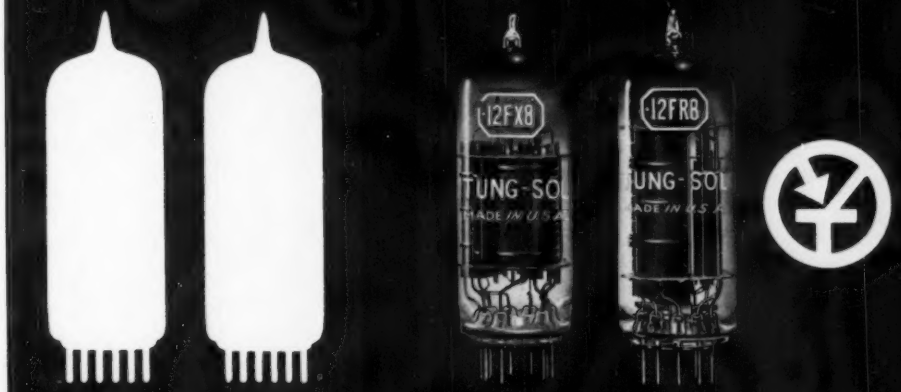
All these standard grades are available with 0.0014" and 0.0028" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*Du Pont Trademark

TUNG-SOL®

12FX8

12FX8 TRIODE-HEPTODE



12FR8 PENTODE-TRIODE-DIODE

12FR8

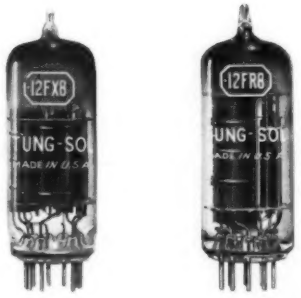
Make Possible a Two-Tube Circuit in conjunction with a Driver and an Output Translator.

TUNG-SOL

12FX8 and 12FR8 provide new economies in the design of automobile radios

Now designers of automobile radios and other hybrid mobile electronic equipment can sharply slice their component requirements to two tubes and two transistors, where previously four tubes and two transistors were needed. That's because Tung-Sol's multi-purpose 12FX8 and 12FR8 combination provides all the functions of the original four tube complement with utmost reliability.

In addition to simplification of circuitry and obvious manufacturing economies, the possibilities for space-saving and heat reduction are indicated.



TYPE 12FX8

MECHANICAL DATA

Coated Unipotential Cathodes—2
Outline drawing ..... Bulb ... T-6½
Base: Jedec E9-1 ..... Miniature button 9 pin
Maximum diameter ..... ⅞ inches
Maximum overall length ..... 2 7/16 inches
Maximum seated height ..... 2 3/16 inches

Base pin connections:
Pin 1—Heptode grid #2 and grid #4
Pin 2—Heptode grid #1 (oscillator grid)
Pin 3—Heptode plate
Pin 4—Heater
Pin 5—Heater, triode cathode
Pin 6—Triode grid
Pin 7—Heptode cathode Shield, Heptode grid #5
Pin 8—Triode plate
Pin 9—Heptode grid #3 (Signal grid)

ELECTRICAL DATA

Heater characteristics*
Heater voltage—nominal ..... 12.6 Volts
Heater current—nominal ..... 300 Amps.

Ratings — Interpreted according to design center system

Maximum heater—cathode voltage	±16 Volts
Maximum heptode plate voltage	16 Volts
Maximum triode plate voltage	16 Volts
Maximum grids No. 2 and No. 4 voltage	16 Volts
Maximum grids No. 2 and No. 4 supply voltage	16 Volts
Maximum negative DC grid No. 3 voltage	16 Volts
Maximum positive grid No. 3 voltage	0 Volts
Maximum grid No. 3 circuit resistance	10 Megohms
Maximum triode grid circuit resistance	10 Megohms

TYPE 12FR8

MECHANICAL DATA

Coated Unipotential Cathodes
Outline drawing ..... Bulb ... T-6½
Base: Jedec E7-1 ..... Miniature button 9 pin
Maximum Diameter ..... ⅞ inches
Maximum overall length ..... 2 7/16 inches
Maximum seated height ..... 2 3/16 inches

Base pin connections:
Pin 1—Triode grid
Pin 2—Triode and diode cathode
Pin 3—Pentode grid #1
Pin 4—Heater
Pin 5—Heater, pentode cathode, pentode grid #3, shield
Pin 6—Pentode grid #2
Pin 7—Pentode plate
Pin 8—Diode plate
Pin 9—Triode plate

Mounting position ..... Any

ELECTRICAL DATA

Heater characteristics*
Heater voltage—nominal ..... 12.6 Volts
Heater current—nominal ..... 0.32 Amp.

Ratings — Interpreted according to design center system

	Pentode	Triode	Diode	
Maximum heater-cathode voltage	—	±16	—	Volts
Maximum plate voltage	16	16	—	Volts
Maximum grids #2 & #4 voltage	16	—	—	Volts
Maximum grids #2 & #4 supply voltage	16	—	—	Volts
Maximum pentode grid circuit resistance	10	—	—	Megohms
Maximum triode grid circuit resistance	—	10	—	Megohms
Maximum plate current	—	—	8	Ma.

*These tubes are intended to be used in automotive service from a nominal 12 volt battery source. The heater is therefore designed to operate over the 10.0 to 15.9 voltage range encountered in this service. The maximum ratings of the tube provide for an adequate safety factor such that the tube will withstand the wide variation in supply voltages.

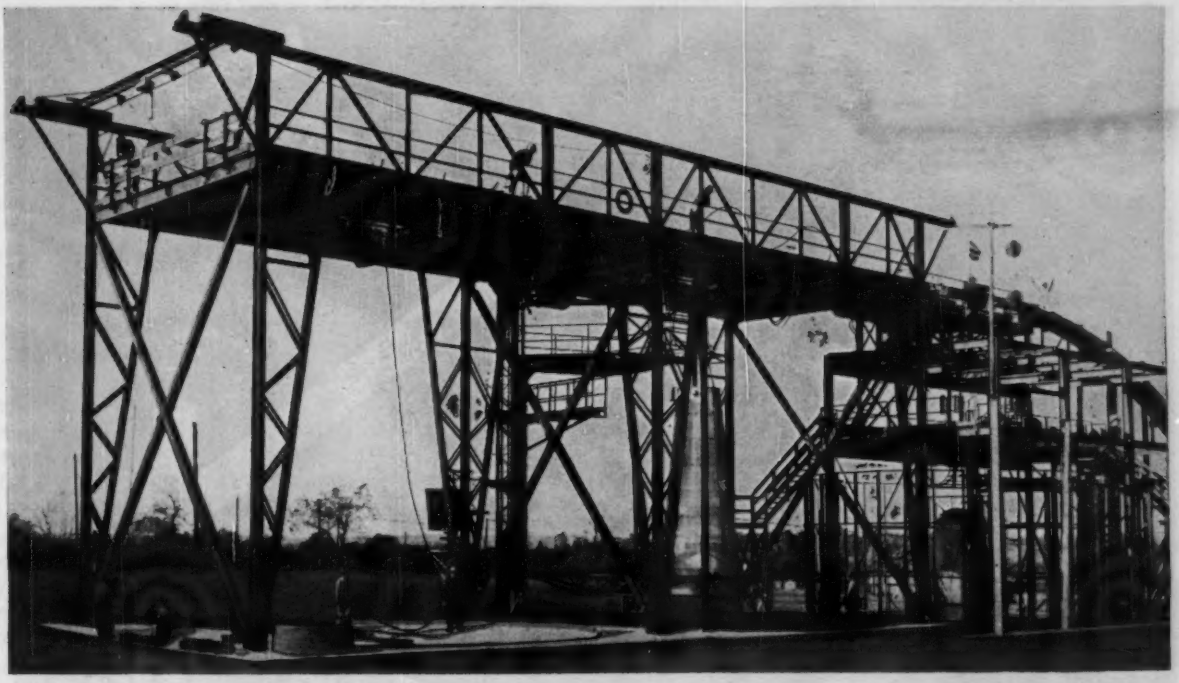
Early Engineering Assistance

Consult Tung-Sol's applications engineers while your equipment is in the preliminary layout stage. Contact any of the Tung-Sol Sales Engineering Offices listed opposite.

TUNG-SOL®

Newark Region: One Summer Avenue, Newark 4, New Jersey • Chicago Region: 1975 North Hawthorne Ave., Melrose Park, Illinois • Columbus Region: 755 W. Goodale Blvd., Columbus 8, Ohio • Detroit Region: Tung-Sol of Mich., Inc. (Rep.) 17500 W. 8 Mile Rd., Detroit 35, Michigan • Dallas Region: 2334 Havenhurst Street, Dallas 34, Texas • Los Angeles Region: 8575 Washington Blvd., Culver City, California • Seattle Region: Ron Merritt Company (Rep.) 1320 Prospect Street, Seattle 9, Washington

JANUARY 1960



SHIP WITHOUT AN OCEAN

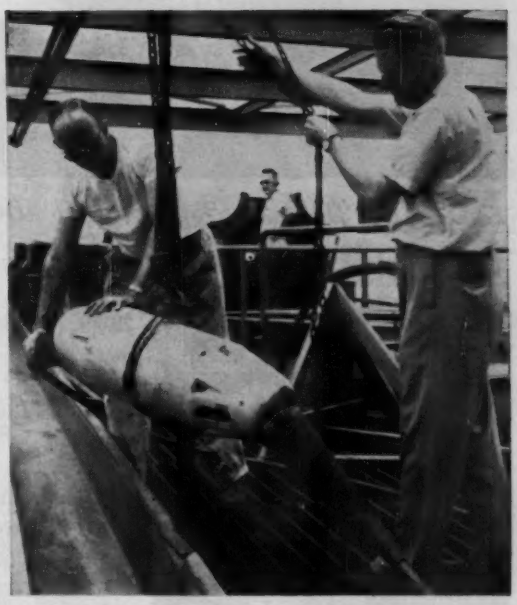
How do you lay a cable on the ocean floor—a cable that is connected to scores of large, heavy amplifiers? How do you "overboard" such a system in a continuous operation, without once halting the cable ship?

Bell Telephone Laboratories engineers must answer these questions in order to lay a new deep-sea telephone system designed to carry many more simultaneous conversations. They're experimenting on dry land because it is easier and more economical than on a ship. Ideas that couldn't even be attempted at sea are safely tested and evaluated.

In one experiment, they use a mock-up of the storage tank area of a cable ship (above). Here, they learn how amplifiers (see photo right), too rigid and heavy to be stored with the cable coils *below* decks, must be positioned *on* deck for trouble-free handling and overboarding.

Elsewhere in the Laboratories, engineers learn how best to grip the cable and control its speed, what happens as the cable with its amplifiers falls through the sea, and how fast it must be payed out to snugly fit the ocean floor. Oceanographic studies reveal the hills and valleys which will be encountered. Studies with naval architects show how the findings can be best put to work in actual cable ships.

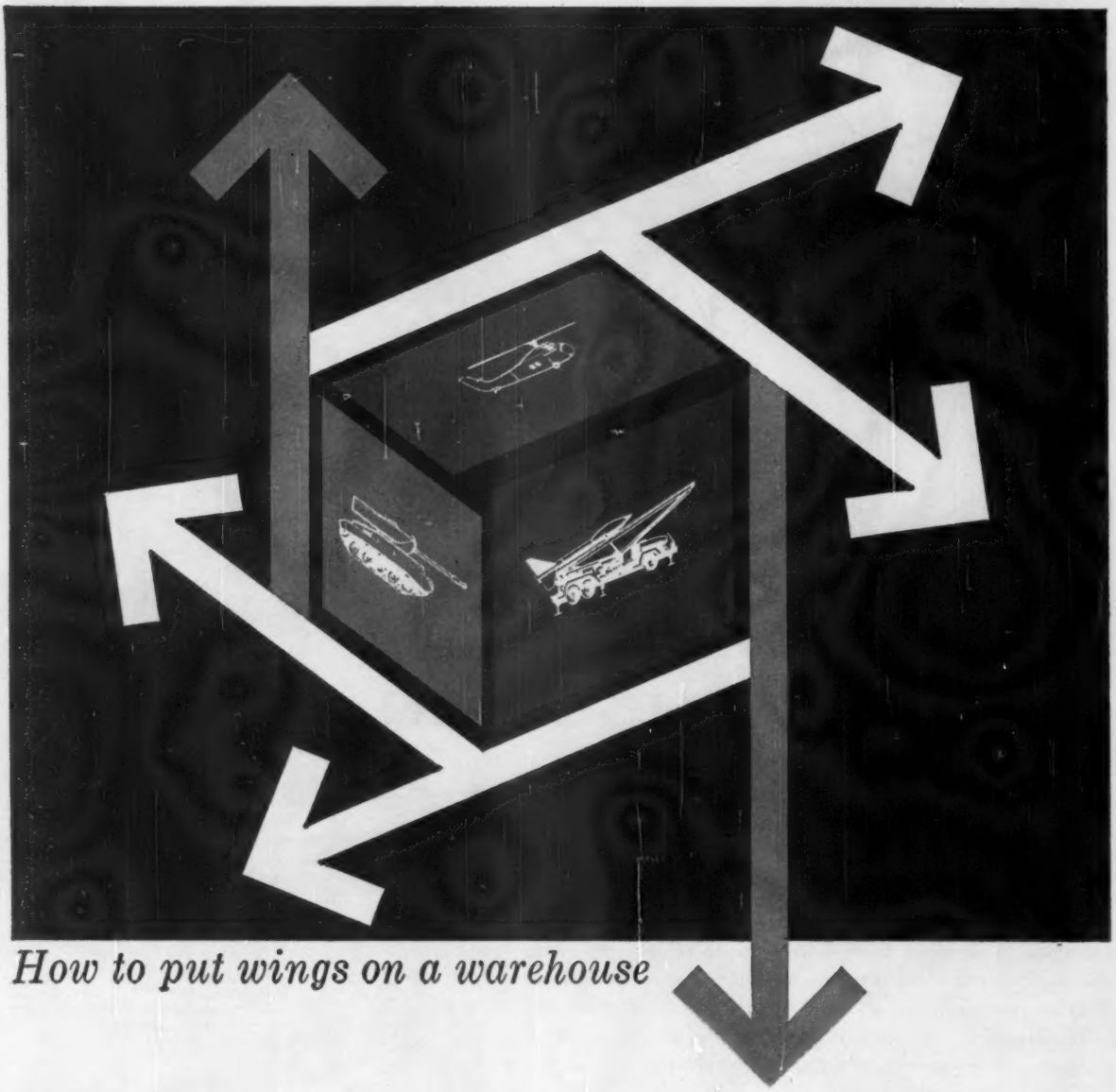
This work is typical of the research and development effort that goes on at Bell Laboratories to bring you more and better communications services.



Experimental amplifier about to be "launched" from "cable ship." Like a giant string of beads, amplifiers and connecting cable must be overboarded without stopping the ship.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



How to put wings on a warehouse

Giving overseas air bases what amounts to local warehouse service on important parts is an Air Force objective. Its present system has slashed delivery schedules up to *20 times*...saved taxpayers several *billion* dollars over the past decade. To improve it further, Douglas has been selected to develop specifications for a comprehensive Material Handling Support System involving better communications, control, cargo handling and loading, packaging and air terminal design. Douglas is well qualified for this program by its more than 20 years in all phases of cargo transport. Air logistics is only one area of extensive Douglas operations in aircraft, missile and space fields in which outstanding openings exist for qualified scientists and engineers. Some are listed on the facing page.

Schuyler Kleinhans and Charles Glasgow, Chief Engineers of the Santa Monica and Long Beach Divisions, go over air transport needs relating to advanced cargo loading techniques with Donald W. Douglas, Jr., President of DOUGLAS

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT

Two Firms in Overseas Mergers

TWO MERGERS involving overseas companies are in the financial news this week. Countries involved are England and Italy.

• **Acquisition of Adrema Ltd.,** a leading United Kingdom manufacturer of business machines has been announced by **Farrington Manufacturing Co.,** Needham Heights, Mass. The acquisition is a cash transaction for an undisclosed sum. The move is expected to strengthen Farrington's position in the data processing field by expanding its range of business machines. Farrington manufactures scanners used to feed information into computers and data processing systems. Adrema has sales operations in 55 countries and operates subsidiaries in Canada and India. This is Farrington's fourth acquisition since March 1959.

• **Hamilton Standard,** division of United Aircraft Corp., Windsor Locks, Conn., reports completion of negotiations leading to the purchase of a 50 percent interest in **Microtecnica,** Turin, Italy. Financial terms of the agreement were not disclosed. The Italian firm has been in existence since 1928. Its main products today are marine and aviation navigation instruments and servomechanisms. It is expected that Hamilton Standard will make use of its acquisition by using Microtecnica facilities for manufacturing items for jet aircraft under license.

• **Telecomputing Corp.,** Los Angeles, has acquired the assets and interests of **Phoenix Engineering & Manufacturing Co.,** Phoenix, Ariz. The transaction did not include the issuance or exchange of TC stock. Sales volume of Phoenix is at an annual rate of $1 million, with expectations that the $1½ million mark may be reached in the year ahead. The firm makes precision missile, aircraft and electronic parts. The firm will be operated as a wholly owned subsidiary with no changes in personnel now contemplated.

• **Eitel-McCullough, Inc.,** San Carlos, Calif. has reached an agreement with **National Electronics** and **Industrial Tubes Inc.,** both of Geneva, Ill. that will make both firms wholly-owned subsidiaries of the California company. The two companies have a combined sales volume of almost $3,000,000. Both companies, which have J. W. Hutchings as president, will turn over all their stock in return for 175,450 shares of Eimac securities, (about 9 percent of total stock outstanding). No cash will be involved in the acquisition.

25 MOST ACTIVE STOCKS

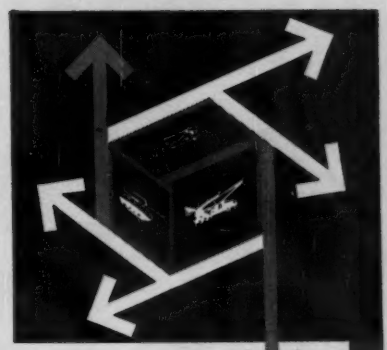
WEEK ENDING DECEMBER 31

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Ampex	1,524	112⅛	100	107¼
Reeves Soderft	833	11¼	10	10⅝
El-Tronics	800	1⅞	1½	1⅞
Gen Dynamics	793	48⅛	45⅛	47
Gen Electric	638	99⅞	93⅞	98½
Sperry Rand	595	26	25⅛	25¼
Collins Radio	578	69⅞	61½	68¾
Sou Tel & Elec	494	85	81¾	84⅛
Elec & Mus Ind	463	11¾	11⅛	11⅜
RCA	462	69½	67	69⅛
Univ Controls	458	18⅝	17⅛	17⅝
Lear Inc	439	20⅝	18⅝	19⅝
Avco Corp	418	16	15⅜	15⅜
Raytheon	403	53⅛	51⅛	52
Int'l Resistance	395	23½	20⅞	22⅛
Muntz TV	375	6½	5⅛	6⅛
Zenith Radio	375	114¾	104	110¼
Philco Corp	366	33⅛	30⅝	32½
Int'l Tel & Tel	354	38⅝	38	38½
Litton Ind	286	67	63	65
Spartan Corp	278	8½	7⅝	8⅛
Burroughs Corp	258	36⅛	33⅛	34
Beckman Inst	249	70	67⅜	67¾
National Union	238	4⅛	3⅝	3¾
Amer Bosch Arma	226	30¼	28⅛	29¼

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.

DIVIDEND ANNOUNCEMENTS

	Amount per Share	Date Payable
Clarostat	3%	Jan. 20
Daystrom	30¢	Feb. 15
Fischer & Porter	2%	Jan. 13
High Vltg Eng	3%	Jan. 21
Packard Bell	2%	Jan. 25
RCA	÷12½¢ 2%	Feb. 1



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MISSILES AND SPACE SYSTEMS

has immediate openings in the following fields—

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Control System Analysis & Design
Antenna & Radome Design
Radar System Analysis and Design
Instrumentation
Equipment Installation
Test Procedures
Logic Design
Power System Design

Mechanical Engineering—
Analysis and Design of the following:
Servo Units
Hydraulic Power Systems
Air Conditioning Systems
Missile Launcher Systems
Propulsion Units and Systems
Auxiliary Power Supplies

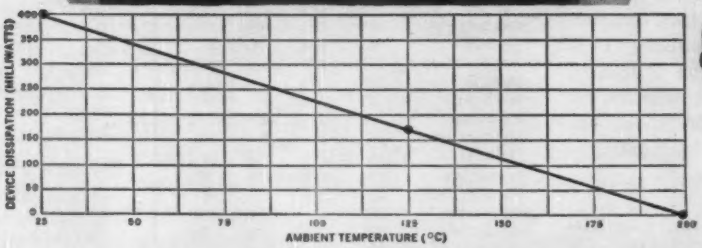
Aeronautical Engineering:
Aerodynamic Design
Advanced Aerodynamic Study
Aerodynamic Heating
Structural Analysis
Strength Testing
Dynamic Analysis of Flutter and Vibration
Aeroelasticity
Design of Complex Structure
Trajectory Analysis
Space Mechanics
Welding
Metallurgy

Physics and Mathematics:
Experimental Thermodynamics
General Advanced Analysis in all fields
Computer Application Analysis
Computer Programming and Analysis
Mathematical Analysis

For full information write to:

Mr. C. C. LaVene
Box F-620
Douglas Aircraft Company, Inc.
Santa Monica, Calif.

2N1440 series PNP silicon alloy transistor news



2N1440 series

Also available:
2N327A Series
2N1228 Series

Surpassing all existing industry standards for PNP Silicon Alloy Transistors (JEDEC 30), the *2N1440 series* extend transistor performance to new, unequalled operating levels. Maximum storage and operating temperatures of 200°C are now a reality. Over the entire temperature range these transistors attain the highest device dissipation—over 170 mw at 125°C in free air. Specifically designed for low level amplification, small signal and medium power applications, and direct coupled linear circuits, the *2N1440 series* operate with guaranteed h_{fe} and I_{CBO} at 150°C. Because of inherent low noise and guaranteed β at low collector currents, they are ideally suited for front end usage.

For complete specifications and delivery dates write, wire or phone:

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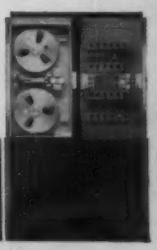
WESTERN REGION OFFICE: 690 N. SEPULVEDA BLVD., EL SEGUNDO, CALIF. • OREGON 8-4161

Distributor: Milgray Electronics Inc. • 136 Liberty St., N. Y., N. Y. • REctor 2-4400

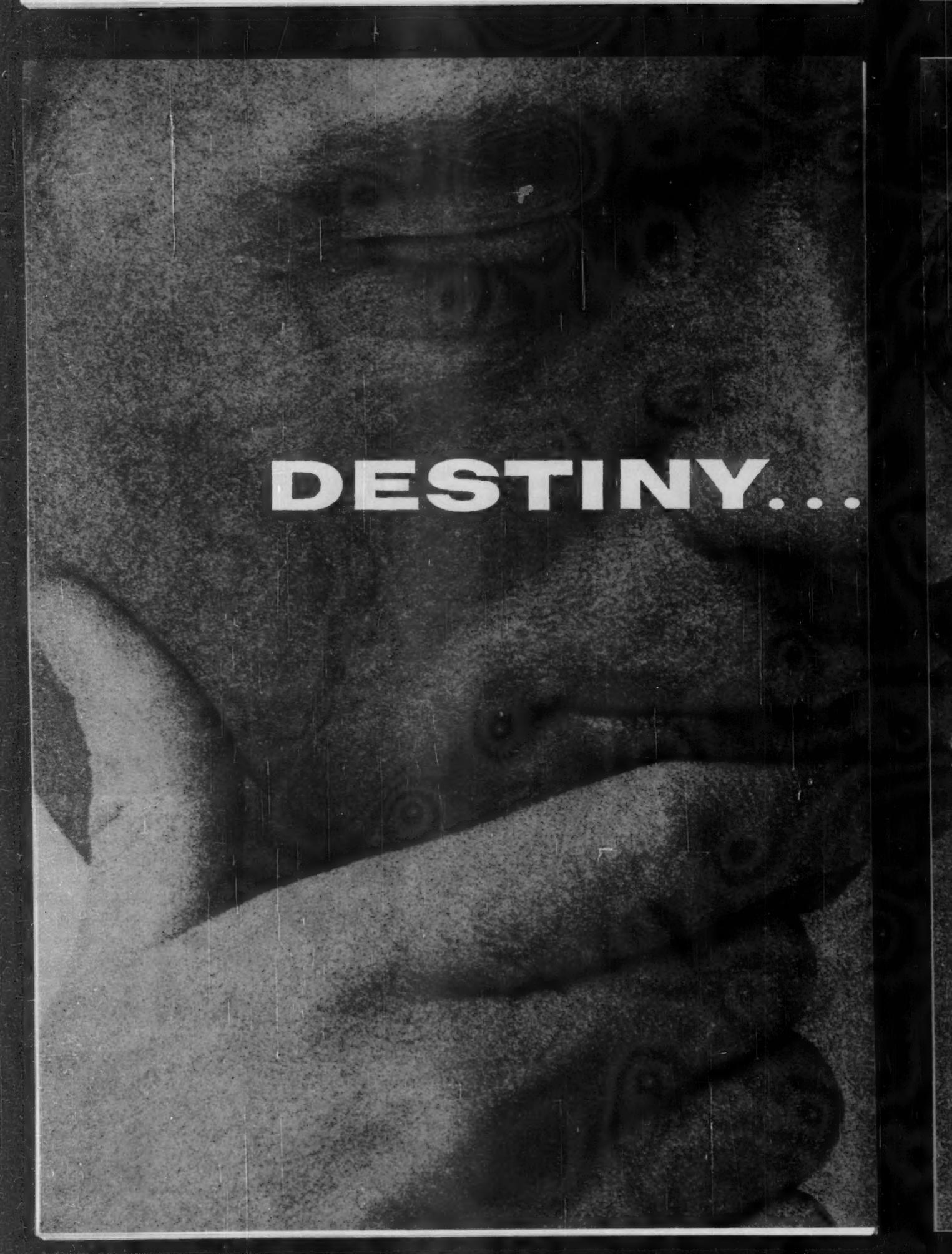
59-2

All magnetic tape recorders consume magnetic tape. Most have a prodigious appetite. It is because they have to run very fast to capture a broad frequency range. Running tape fast is the easy way to get wide bandwidth. But you pay for that bandwidth again and again with every data run in every month of every year you use the machine. You pay in high tape consumption and high tape costs. The Ampex FR-600 achieves the same bandwidths at half the tape speed you now need. At half the tape cost therefore. At 60 ips the FR-600 has a 250 kc bandwidth. At 30 it has 125 kc and so on. No matter what the bandwidth you can now record it at half the speed, on half the tape, at half the cost on an FR-600. The savings in just a short time can be astonishing. If you use 30 14-inch reels of 1-inch, 1-mil tape each week your weekly tape bill is $5100—minimum. An FR-600 can save half of that each week and literally buy itself in 15 weeks. In your particular case it might take more time —or less—but it's a fascinating reason for getting the full FR-600 story. AMPEX DATA PRODUCTS CO., 934 Charter St., Redwood City, Calif.

This instrumentation recorder can buy itself in 15 weeks



FR 600 AMPEX


DESTINY...

and the ticking seconds

"Thinking" projects, surely. But also "doing" projects. And the time is short, always, to continually equip our military with electronic weapons that defend us successfully.

Electronic Defense Laboratories, Reconnaissance Systems Laboratory, Special Tube Operations—these are some of the elite, sophisticated, compact groups that form Sylvania MVO.

Mountain View Operations—40 minutes south of San Francisco, in the Berkeley-Stanford scientific complex—professional atmosphere for you, fortunate living for yours.

If your specialty appears below, Mr. Wayne Pearson would welcome your confidential resumé or telephone call. Address him at Sylvania MVO, (Dept. A1) Box 188, Mountain View, Calif.

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CES ELECTRONIC PRODUCTS, Inc.

CES LOGARITHMIC ATTENUATORS

are non-linear attenuating networks whose output voltage amplitude is a linear function of the logarithm of the input voltage amplitude. Models with ranges to 60 db are available. Price range $59.00 to $98.00.

CES TWIN-T REJECTION FILTERS

consist of two parallel networks whose outputs add out of phase to null a particular frequency. The advantage of this type network is that there is a common connection between input and output. Special attention is paid to temperature coefficients of components to insure stability over wide temperature limits. CES Twin-T Filters can be supplied in three models for any one frequency between 15 and 1500 cps with frequency tolerances of ±2% or ±0.3%. Price range $15.00 to $36.00.

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can be supplied for both general and special purpose applications. The Model 104B is a general purpose low noise 60 db gain Pre-Amplifier. The Model 105B is a Logarithmic Attenuator Driver Amplifier and finds wide application wherever a relatively high output is required. The Model 106B is a Detector Amplifier featuring low impedance output. The Model 107B peaked amplifier is a high gain, high Q amplifier which acts as a high Q resonant circuit. Price range $40.00 to $95.00.

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MARKET RESEARCH

Instrument Sales Rise Fast

SALES of electronic test instruments to both industry and the armed forces, which are growing at the rate of 15-20 percent per year, will increase to at least $350 million in 1960, predicts Albert T. Craig, president of Technical Information Corp. TIC is a New York consulting group which prepares analyses of available electronic test equipment.

Reflecting the continued growth in use of transistors, one fifth of the test instrument industry's 1960 sales gain will be in the area of power supplies, Craig says. The power supply market should increase from $60 million in 1959 to at least $70 million in 1960.

The introduction of high-speed oscilloscopes was last year's outstanding single development in the instrument field, claims Craig. Rapid growth in sales of these oscilloscopes can be expected in 1960.

Manufacturers of pulse generators have the opportunity in 1960 to make significant new developments in their product, according to Craig. Pulse generators require faster rise times for designing and testing new computer circuits, he explains.

• **Sales of electronic test, recording and measuring instruments** to industry alone may reach $275 million, according to Glen Andrews, industrial specialist with Arthur D. Little, Inc., engineering and management consultants. His forecast is up 10 percent from estimated sales in 1959.

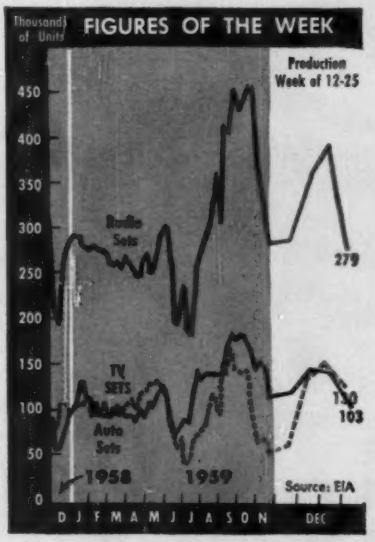
In addition to estimating total industrial test instrument sales for these two years, Andrews has made the following estimates of individual test instrument sales, all in millions of dollars.

	1959	*1960*
Oscilloscopes	$10	$11
Oscillographs	15	16
Volt-ohmmeters	9	9
R,C,L measuring equipment	3	4
Analyzers for engine testing	25	25
Tube testers	6	5
Microwave test equipment	10	15
Signal generators	15	15
Transmitter test equipment	3	3
R-f measuring equipment	7	8
Indicating instruments	25	27
Recording instruments	30	30
Ultrasonic	4	5
Other test equipment	88	102
Total	$250	$275

• **Manufacturers of electrical wire and cable** look forward to a 10 percent sales increase in 1960 over the past year with sales moving up from $1.504 billion in 1959 to $1.654 this year, National Electrical Manufacturers Association predicts. In the past the electronics industry has taken about 17 percent of total production of electrical wire and cable.

NEMA also anticipates 1960 output of $6.333 billion worth of electronics and communications equipment at factory-door price, a gain of eight percent over 1959. However the association includes telephone equipment and signaling apparatus along with a wide variety of electronics in this estimate.

• **Philco Corporation and CBS-Electronics,** a division of Columbia Broadcasting System, jointly announce the signing of a cross-licensing agreement covering the manufacture and sale of semiconductors.



For Airborne Equipment

MORE POWER LESS WEIGHT LESS SPACE

with new CBS PNP Power Transistors

Compact, lightweight servo amplifier employing CBS 2N1434 10-watt push-pull output stage.

In a typical servo amplifier, a pair of these CBS PNP germanium power transistors delivers 10 watts output. Yet each transistor weighs less than 5 grams . . . and requires only ½ square inch of chassis space. Put the compact CBS 2N1433, 2N1434, 2N1435 to work in your military or industrial equipment — airborne, mobile or portable. Check advantages and basic data. Write for complete technical bulletin E-370. Order from your Manufacturers Warehousing Distributor.

NOTE THE ADVANTAGES

These improved versions of the 2N529, 2N529A and 2N540 offer:

- Single, sturdy 10-32 mounting stud
- Compact male-industrial TO-10 welded package
- High dissipation with minimum size
- High collector-to-base voltage
- High collector-emitter breakdown voltage
- Wide range of operating and storage temperatures

CHECK THE CHARACTERISTICS

Type	Max. W Diss.*	Max. V_{CBO}	Min. BV_{CBO}	h_{FE} (I_C=2A, V_{CE}=−2V) Min.	h_{FE} (I_C=2A, V_{CE}=−2V) Max.	V_{BE} (I_C=2A, V_{CE}=−2V) Min.	V_{BE} (I_C=2A, V_{CE}=−2V) Max.	Max. Thermal Res. °C/W
2N1433	35	−80	−50	20	50	—	3.3	2
2N1434	35	−80	−50	45	115	—	1.8	2
2N1435	35	−80	−50	30	75	1.0	2.5	2

All types have: Max. collector current, 3.5 amps; junction temperature, −65 to +95°C; max. saturation voltage, 0.6 volts (I_C=2A, I_B=200 mA). Minimum alpha cutoff frequency is 200 KC (I_C=100 mA, V_{CE}=−4 volts).

*25°C base mounting temperature.

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CBS semiconductors

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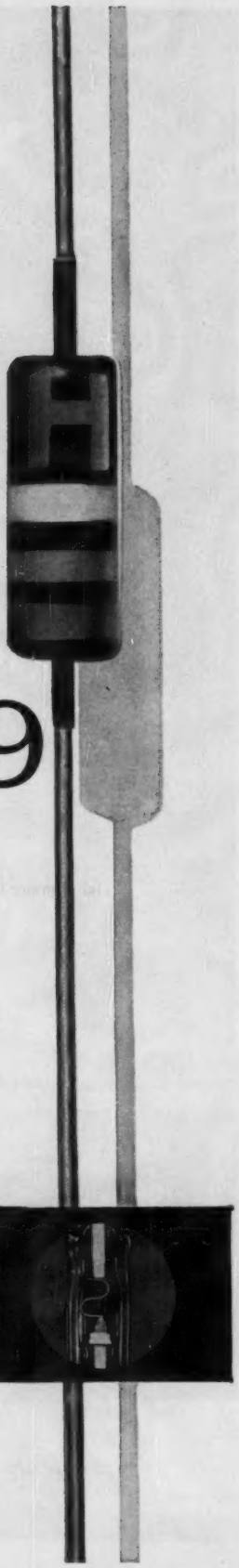
4 day delivery: Fused Silicon Diodes

1N645 1N646 1N647 1N648 1N649



Hughes now offers you immediate delivery on five medium power fused silicon glass diodes—types 1N645, 1N646, 1N647, 1N648, and 1N649.

These Hughes diodes feature a Dumet-stud heat sink for small size and the popular Hughes glass package for proven reliability. Widely used in power supplies, magnetic amplifiers and similar circuits, these Hughes diodes are specially designed to meet the severe environmental requirements of such military equipment as missile telemetering links, airborne radar, and communication gear.

For immediate delivery of these Hughes diodes write, wire or phone the Hughes distributor or Semiconductor Division Sales Office nearest you...or write Hughes Semiconductor Division, Marketing Dept., Newport Beach, California.

Specifications

Type	Max. Working Voltage	Min. Forward Current @ specified voltage*	Max. Reverse Current at working voltage* (μA)	DC Current Io (μA)
1N645	225V	400 mA @ 1.0V	.2	400
1N646	300V	400 mA @ 1.0V	.2	400
1N647	400V	400 mA @ 1.0V	.2	400
1N648	500V	400 mA @ 1.0V	.2	400
1N649	600V	400 mA @ 1.0V	.2	400

* @ 25° C

SEMICONDUCTOR DIVISION

the West's leader in advanced ELECTRONICS

HUGHES PRODUCTS

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Where EECo timing equipment counts

ELECTRONIC ENGINEERING COMPANY'S
List of major instrumentation timing contracts

- **AIR FORCE MISSILE TEST CENTER**
  - Atlantic Missile Range Dual Central Timing Signal Generator
  - Downrange Central Timing Signal Generators
  - Terminal Timing Signal Systems
  - On-Site Sub-Central Timing Systems
  - Ballistic Missile Launching Control System
  - Instrumentation Timing and Ballistic Missile Launching System
- **NAVAL AIR MISSILE TEST CENTER**
  - Instrumentation Timing System Study
  - Design and Development of Sea Test Range Timing System
  - Various Special On-Site Instrumentation Timing Signal Equipments & Systems
  - Launching Control System Design
- **AIR FORCE FLIGHT TEST CENTER**
  - Photographic Instrumentation Timing System Study
  - Design and Development of Camera Timing System
  - Design and Construction of Timing and Calibration Unit
  - Design and Construction of Recording and Distribution Systems for Timing Signals
  - Design and Development of Central Time Code Generator
- **NAVAL ORDNANCE TEST STATION**
  - Development of Test Vehicle Launching Control System
- **ROYAL CANADIAN AIR FORCE**
  - Central Timing System for Cold Lake Station
- **NATIONAL BUREAU OF STANDARDS**
  - Time Interval Selector
- **U.S.S. MISSISSIPPI**
  - Shipboard Missile Timing Equipment
- **U.S.S. NORTON SOUND**
  - Shipboard Missile Timing Equipment
- **ABERDEEN PROVING GROUND**
  - Time Code Generator
- **FT. HUACHUCA**
  - Timing System for Electronic Proving Ground
- **AEROJET-GENERAL**
  - Time Signal Distribution System (Pacific Missile Range)
  - Range Timing System (Pacific Missile Range)
- **DOUGLAS AIRCRAFT COMPANY**
  - Transistorized Airborne Time Code Generator
  - SADAP Timing System
  - Time Code Generator (Ground)
- **LOCKHEED AIRCRAFT CORPORATION**
  - Time Code Generator
  - Terminal Timing System
- **PHILCO CORPORATION**
  - Satellite Instrumentation Timing System
- **SYLVANIA**
  - Code Generator System
  - Time Code Generator

From the Atlantic to the Pacific whenever a missile leaves the launching pad odds are better than 5 to 1 that its instrumentation is being coordinated by timing signal systems made by Electronic Engineering Company of California. In the 10 short years since it first launched a basic study of timing, EECo has become the leading supplier of this type of equipment in the United States. This background of experience enables EECo to produce rapidly and economically the instrumentation timing systems and components so vitally needed for the space age.

Several important career opportunities are now available in EECo's engineering department. For further information, call or write Merl Perkins.

Electronic Engineering Company *of California*

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EE 9-0

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new improved "Memo-Scope®" oscilloscope

Still using "old-fashioned" methods for measuring non-recurring transients? If so, now is the time to investigate the easy way to solve your most difficult transient measurement problems with the latest model Hughes "Memo-Scope" oscilloscope.

Why? Because *new* features, *new* advanced circuitry, *new* panel layout and *new* mechanical design now assure maximum accuracy in all your transient measurements—*plus* higher performance, greater dependability and easier operation!

The Hughes "Memo-Scope" oscilloscope (Model 104E) stores nonrepetitive events for an indefinite period—hours, or days—keeping them available for thorough study until intentionally erased.

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  - Far greater accessibility for maintenance,
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- Ultrasonic flaw detection
- Semiconductor testing
- Ballistics and explosives research ...and many others.

INDUSTRIAL SYSTEMS DIVISION

HUGHES PRODUCTS

For complete information on the new improved Hughes "Memo-Scope" oscilloscope (Model 104E), detailed data sheets and application analysis of your transient measurement problems, write or wire: HUGHES PRODUCTS Industrial Systems Division, International Airport Station, Los Angeles 45, California

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Higher permeability values now guaranteed for Allegheny Ludlum's Moly Permalloy

Means new, consistent and predictable magnetic core performance

Molybdenum Permalloy nickel-iron strip is now available from Allegheny Ludlum, with higher guaranteed permeability values than former typical values. For the buyer, this new high quality means greater uniformity . . . more consistent and predictable magnetic core performance.

This higher permeability is the result of Allegheny Ludlum's intensive research on nickel-bearing electrical alloys. A similar improvement has been made in AL-4750 strip steel. A-L continues its research on silicon steels, including Silectron, well-known grain-oriented silicon steel, and other magnetic alloys.

Complete facilities for the fabrication and heat treatment of laminations are available from Allegheny Ludlum. In addition, you can be assured of close gage tolerance, uniformity of gage throughout the coil, and minimum spread of gage across the coil-width.

If you have a problem relating to electrical steels, laminations or magnetic materials, call A-L. Prompt technical assistance will be yours. And write for more information on Moly Permalloy. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

Address Dept. E-25.

WSW 7490

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Choose your High Temperature from the

15 Types of Mallory Tantalum Capacitors to Choose From ... Seven Types for High Temperatures

Type	Description	Capacity Range	W. Volts DC Rtg. at 85°C	Temp. Range	Case Style	Body Length	Body Diameter
M2	Pellet Anode—Liquid Electrolyte	11-140 mfd.	90-6V.	—55 to +150°C	Metal Case-Axial Leads	.500"	.287" (Body) .484" (Flange)
XTK	Pellet Anode—Liquid Electrolyte	2-70 mfd.	340-8V.	—55 to +175°C	Metal Case-Axial Leads or Terminal	.438" to 1.313"	.625"
XTM	Pellet Anode—Liquid Electrolyte	4-140 mfd.	340-8V.	—55 to +175°C	Metal Case-Axial Leads or Terminal	.566" to 1.800"	.625"
XTL	Pellet Anode—Liquid Electrolyte	3.5-120 mfd.	630-18V.	—55 to +200°C	Metal Case-Axial Terminal	.500" to 2.595"	.875"
XTH	Pellet Anode—Liquid Electrolyte	7-240 mfd.	630-18V.	—55 to +200°C	Metal Case-Axial Terminal	.688" to 4.065"	.875"
XTV	Pellet Anode—Liquid Electrolyte	18-1300 mfd.	630-30V.	—55 to +175°C	Metal Case-Axial Terminal	.563" to 2.750"	1.125"
XTO	Pellet Anode—Liquid Electrolyte	7-240 mfd.	630-18V.	—55 to +200°C	Metal Case-Axial Terminal	.563" to 2.750"	1.125"

XTL

XTH

XTO

XTV

... And Eight Other Types

HAT: microminiature, 1-10 mfd., —20 to +85°C, metal case
TAS: miniature, solid type, .33-330 mfd., —80 to +85°C, metal case
TAM: microminiature, solid type, 6.8-56 mfd., —55 to +85°C, encapsulated
TAF: foil type, .25-440 mfd., —55 to +85°C, metal case
STNT: subminiature, 2-40 mfd., —55 to +85°C, metal case
TNT: miniature, 4-80 mfd., —55 to +85°C, metal case
TAP: miniature, 2-30 mfd., —55 to +100°C, metal case
TAP2: miniature, 11-140 mfd., —55 to +85°C, metal case

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TYPICAL CHARACTERISTICS

Kearfott Unit No.	P1241-11A
Code	Cyclic Binary
Range	0-32,768 (2^{15})
Bits per Revolution	16
Revolutions for Total Range	2,048
Volts D.C.	10.5
Current (ma.)	20
Inertia (gm. cm.²)	20
Unit Diameter (in.)	1 1/16
Unit Length (in.)	3
Life	10^6 Revolutions or 10^3 hours
Static Torque (in.-oz.)	2 (break) 1 (running)
Weight (oz.)	5
Maximum Speed (RPM)	600

Write for complete data.

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TYPICAL CHARACTERISTICS — SIZE 25

Type Resolver	Transmitter	Control Transformer
Part Number	Z5161-001	Z5151-003
Excit. Volts (Max.)	115	90
Frequency (cps)	400	400
Primary Imped.	400/80°	8500/80°
Secondary Imped.	260/80°	14000/80°
Transform. Ratio	.7826	1.278
Max. Error fr. E.Z.	20 seconds	20 seconds
Primary	Rotor	Stator

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TYPICAL CHARACTERISTICS

	Size 11 (R860)
Excitation Voltage (400 cps)	115
Volts at 0 rpm (RMS)	.020
Volts at 1000 rpm (RMS)	2.75
Phase shift at 3600 rpm	0°
Linearity at 0-3600 rpm	.07
Operating Temperature Range	−54° +125°

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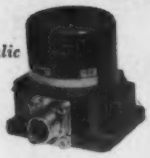

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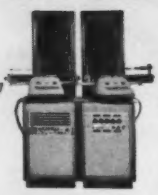

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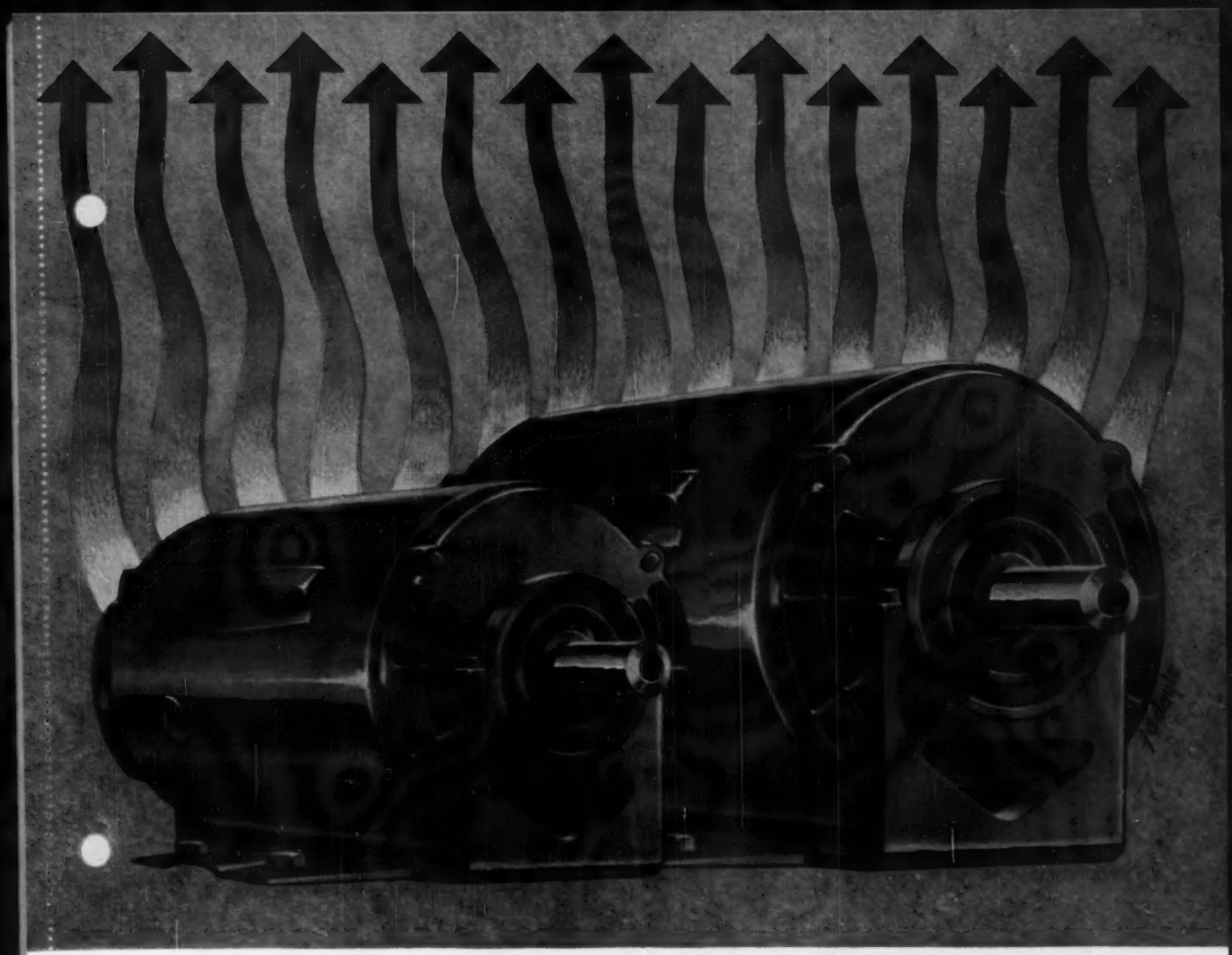

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Anatherm—the first film-coated magnet wire to qualify for the AIEE Class F (155°C) rating has been field-tested and proved. Our broad application experience with Anatherm allows us to offer this wire in Sizes 8 to 46 in standard film thicknesses, and in a full range of round, square and rectangular sizes.

For more information, see the Man from Anaconda. Look up "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y. 89250

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ANACONDA®

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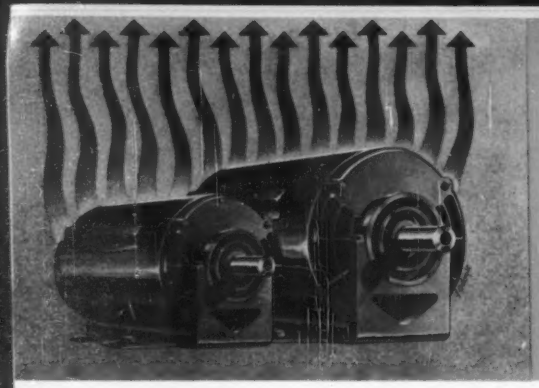

MAGNET WIRE DATA SHEET

from

Anaconda Wire & Cable Co.

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...about Anatherm 155°C (AIEE Class F) Magnet Wire

When proper advantage is taken of Anaconda Anatherm's higher 155° C characteristics, electrical equipment can be improved in these ways:

RAISES LIMITING OPERATING TEMPERATURES. Anatherm raises limiting operating temperatures to 155°C. This high heat resistance means extra protection . . . longer equipment life . . . wider range of applications.

REDUCES FRAME SIZE. Anatherm gives more horsepower from the same space or the same horsepower from a smaller motor. Costs are cut for you, and your customers benefit from smaller over-all components.

INCREASES HORSEPOWER RATINGS. Anatherm is the best of the polyesters. Its high heat resistance means higher permissible operating temperatures, greater horsepower rating.

UPGRADING. Anatherm helps upgrade standard equipment. Gives added heat insurance through thermal stability. Particularly suited for overloads.

COMPATIBILITY. With polyesters, importance must be placed upon a completely compatible system. Varnish manufacturers have recently developed polyester varnishes which allow a compatible polyester magnet wire system. A number of varnishes other than polyester are compatible with Anatherm, but consultation with varnish suppliers before use is recommended.

TECHNICAL PROPERTIES

MECHANICAL PROPERTIES

Anatherm has unusually high abrasion-resistance. This characteristic allows it to be wound on both conventional and automatic winding equipment. Anatherm offers excellent flexibility and adherence properties. It meets NEMA snap test requirements and exhibits excellent adherence to the conductor.

ELECTRICAL PROPERTIES

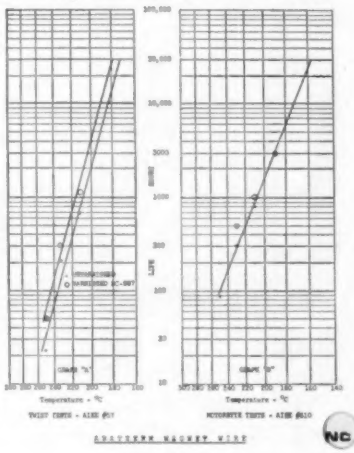
Anatherm maintains its dielectric strength under prolonged heating at high temperatures. It consistently exceeds dielectric strength requirements for NEMA dielectric twist test.

CHEMICAL PROPERTIES

Anatherm will resist toluol, VM & P Naphtha, Ethyl Alcohol and 5% Sulphuric Acid. Anatherm is a polyester and exhibits the best characteristics of this class of chemical compound. However, all polyesters must be used with certain precautions where moisture and/or enclosed systems are concerned. Similar precautions must be taken where chlorine-base supporting insulations, such as neoprene and polyvinyl chloride, are present. Polyesters should not be used in applications subject to exposure to concentrated alkalies.

THERMAL PROPERTIES

Anatherm is offered as a 155°C (AIEE Class F) magnet wire based on AIEE #57 and #510 test methods. These tests, performed by Anaconda engineers, show Anatherm as being capable of a 30,000-hour life at 157°C in an unvarnished state and the same life at 175°C when treated with a silicone or polyester type varnish. Thus Anatherm, when suitably varnished, has reserve stability even above the 155°C rating at which it is being offered. The thermoplastic flow temperature for Anatherm, based on MIL-W-583A, is very high (250°C). Anatherm also shows outstanding retention of flexibility after aging. Wire can be heated 168 hours at 175°C and then wound on three times its own diameter without cracking. Its heat-shock characteristics are exceptionally good for a polyester wire: Anatherm will withstand a 1x mandrel wrap at 155°C for one hour.



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Why U.S. Buys Missiles Abroad

Our first wire-guided missile designs will come from Europe, but there is big production and new design business left for U.S. firms

THOUGH EUROPEAN MISSILEMAKERS have been quick to achieve a beachhead in the U.S. market for antitank wire-guided missiles, the market has actually just opened.

If the French and West German missiles now being evaluated by the U. S. Army (French SS-10, 11) and Marines (West German Cobra) are accepted, U. S. firms still have a chance to bid for manufacturing rights for the foreign birds. Also, the missiles being tested represent only two of four categories of such weapons needed by the ground forces today.

Why did European firms get the jump on the U. S. in this field? Two reasons: They planned ahead and they didn't have much money.

Anticipated Demand

NATO's military strategists foresaw the need for a transportable, accurate, nonjammable antitank missile while the U. S. Army clung to the 106 recoilless rifle. European firms with limited defense funds began experimenting with bazooka-type weapons with aerodynamic stability.

Before long cheap, unsophisticated and easy-to-operate wire-guided missiles had been produced by England (Vickers' Vigilant, for which Clevite has a U.S. agreement), France (Nord Aviation's SS-10, 11, and the French Army Laboratory's two versions of Entoc), Switzerland (Oerlikon's Mosquito), Sweden (Bofors' Bantam), and Germany (Boelkow Entwicklungen's Cobra).

What the Troops Need

Although the Army needed three, or possibly four, categories of short-range missiles, Army put all its effort in the Dart. This fact, plus an adequate budget, resulted in too-frequent specification changes. Dart ended up heavy, sophisticated, expensive. Chalking the project up to experience, Army cancelled the program.

The categories the Army needs are: a Light Assault Weapon (LAW) transportable by a man and weighing about 30 lb; Medium Assault Weapon (MAW) transportable by jeep and weighing from 50 to 100 lb; Heavy Assault Weapon (HAW) launched from a tank-killer vehicle, possibly an armored jeep; and a tank missile. The last two categories cannot be wire-guided. West German missilemakers with long experience with this technique (X-4 air-to-air missile was developed during World War II) say the maximum practical range for wire is from three to four miles.

Although Army may decide to combine categories one and two, LAW and MAW, into a single weapon, both categories are currently being evaluated: the French SS-10 as a LAW (1½-mi range) and the SS-11 (2½-mi range) as a MAW.

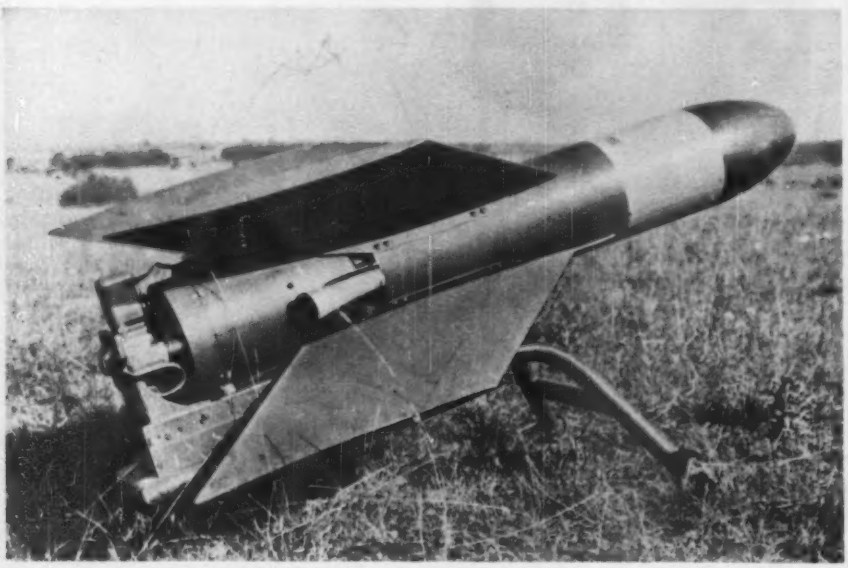
Waiting for Results

The Marine Corps has tested both French missiles and is now waiting for results to be evaluated. Meanwhile, the Corps has bought 100 Cobras from West Germany—where the missile is already operational with the Bundeswehr—for testing at Camp Pendleton, Calif. this month. Produced by Boelkow Entwicklungen of Munich, the Cobra will be produced in the U. S. and sold here and in Canada by Daystrom.

A candidate for the third category, HAW, may not appear for some time. The U. S.-designed Lacrosse radio-command missile is the closest solution. It is believed, however, that the Army will want a lighter and more transportable missile in addition to Lacrosse.

Tank Destroyers

Category four, a tank missile called the Shillelagh, is expected to be operational at midyear. It's now under development by Aeronutronics Systems, subsidiary of



French SS-11 antitank wire-guided missile is being evaluated by the U.S. Army

Ford Motor, with Raytheon as subcontractor for fire control. The contract amounts to $23 million.

Feelers Sent Out

While evaluating the French missiles, Army sent out feelers to American industry for proposals for antitank missiles. And although more than two dozen firms have sent in company-financed proposals, Army has not yet made a choice. Probable reasons: Army wants to study existing foreign weapons before jumping into another U. S. development project; Army may decide to combine categories one and two; and, Army's budget may have been strained by the $23-million Shillelagh award.

Going into its test phase this month, the Cobra is 30.7 in. long and 3.9 in. in diameter. It weighs 20 lb, carries 5.5 lb of explosives or chemicals. High explosives reportedly would penetrate 21.5 in. of armor plate. Nerve gas could kill, almost instantly, hundreds of enemy troops.

Powered by solid fuel, the Cobra travels at a top speed of 191 mph and has a range up to 1½ mi. It can be fired from the ground, an aircraft or a vehicle. Its four fins, cruciform in shape, are constructed at angles of 90 degrees to the body. The two lower fins support the weapon on the ground and serve as a launching platform.

The Cobra is controllable from the moment it leaves the launching site. The gunner guides the flight of the missile by wire from a hidden position through a 4.4-lb control box so constructed that the gunner can carry it in a pocket sewn to his trouser leg, or by a belt around his body.

How Cobra Works

One guidance control unit can launch and control as many as eight Cobras. Launching is accomplished by a selector switch on the control box.

The operator guides the bird to its target by manipulating a control stick up or down, to the right or left.

The control stick operates from a series of pick-offs which provide the corresponding voltage changes to the missile during its flight.

West Germany's wire-guided Cobra, to be evaluated by the Marines, weighs 20 lb, will cost $1,000 each

Both control box and missile are transistorized. The German-made receiver in the missile uses hand-soldered circuitry.

Daystrom is working on a modular type receiver that will be incorporated in the U. S.-manufactured missiles.

On the exterior top of the body is the battery that provides the electrical impulses to ignite both rockets and a tracking flare and to amplify flight direction signals from the control unit to the spoilers to guide the weapon in flight. On the underside is the booster rocket, so canted that it starts the missile on its flight at a 22-degree take-off angle.

Inside the body and wrapped around the sustainer rocket is a reel of guidance wire that spins out through a hole at the rear. The sustainer rocket keeps the missile at constant speed until the target is reached.

Versatility Is Factor

The U. S. and Canadian market for wire-guided missiles will be big. How big depends on the weapons' versatility. Potential tactical applications go beyond defense against enemy tanks. A wire-guided missile carrying an atomic warhead (although to date atomic warheads don't come this small) could erase an underground command post, building or a concentration of troops. The rocket could spread nerve gas, psychochemicals or even tear gas. Such a variety of uses would create requirements for the missile in a number of units beyond those with antitank missions.

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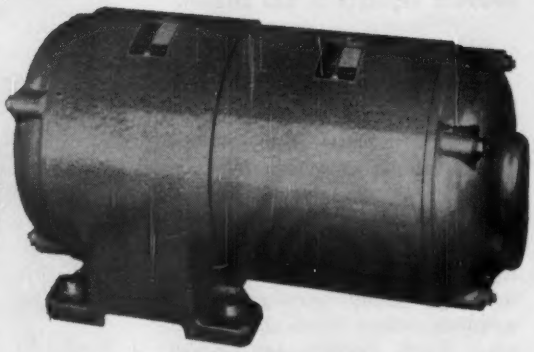

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Produced by the Precision Power Division of American Electronics, Inc., Model 275 Inductor Alternator, illustrated above, operating from 60 cycles AC, meets power supply requirements of MIL-E-7894. Total harmonic content is under 5%. Output voltages are automatically regulated to within ±1% and are manually adjustable to ±10% from nominal. Specific models for specific requirements are listed in the table.

Other standard alternators in sizes from 500 watts to 120 KVA, with fixed or variable output frequencies ranging from 250 to 10,000 cycles, are in production. Please write for our new brochure which gives complete details on Model 275 and American Electronics' line of rotary power supply units. A new brochure is also available covering AMSTAT Static Power Devices produced by the Precision Power Division of American Electronics.

REQUIREMENT	INPUT		OUTPUT		MODEL NO.
	VOLTAGE	HP	WATTS @ 1.0 P.F.	VOLTAGE	
3-PHASE INPUT AND 3-PHASE OUTPUT	220/440	1	500	115/200	275FA
	220/440	2	1000	115	275BA
	220/440	3	1800	115/200	275E
	220/440	3	1800	115	275EA
	550	3	1800	115/200	275K
	220	3	1800	115/200-115	275LA
	208	3	1800	115	275M
	550	3	1800	115	275N
3-PHASE INPUT AND 1-PHASE OUTPUT	220/440	1	500	115	275CA
	220/440	2	1000	115	275B
	208	2	1000	115	275G
	115/230	2	1000	26	275H
	208	2	1000	26	275HB
1-PHASE INPUT & 3-PHASE OUTPUT	115/230	1	500	115/200	275F
	115/230	2	1000	115/200	275BB
	115/230	2	1000	115	275AA
	115/230	3	1800	115/200	275DC
1-PHASE INPUT & 1-PHASE OUTPUT	115/230	1	500	115	275C
	115/230	2	1000	115	275A
	115/230	3	1800	115	275Y

Weight:	125 to 140 lbs.
Output Frequency:	400 CPS nominal
Maximum Total Harmonic Distortion:	5%
Voltage Regulation:	±1%
Voltage Adjustment:	±10% from nominal
Size: with 3-phase meter	20" L x 12" W x 9¾" H
with single-phase meter	21⅝" L x 12" W x 11" H

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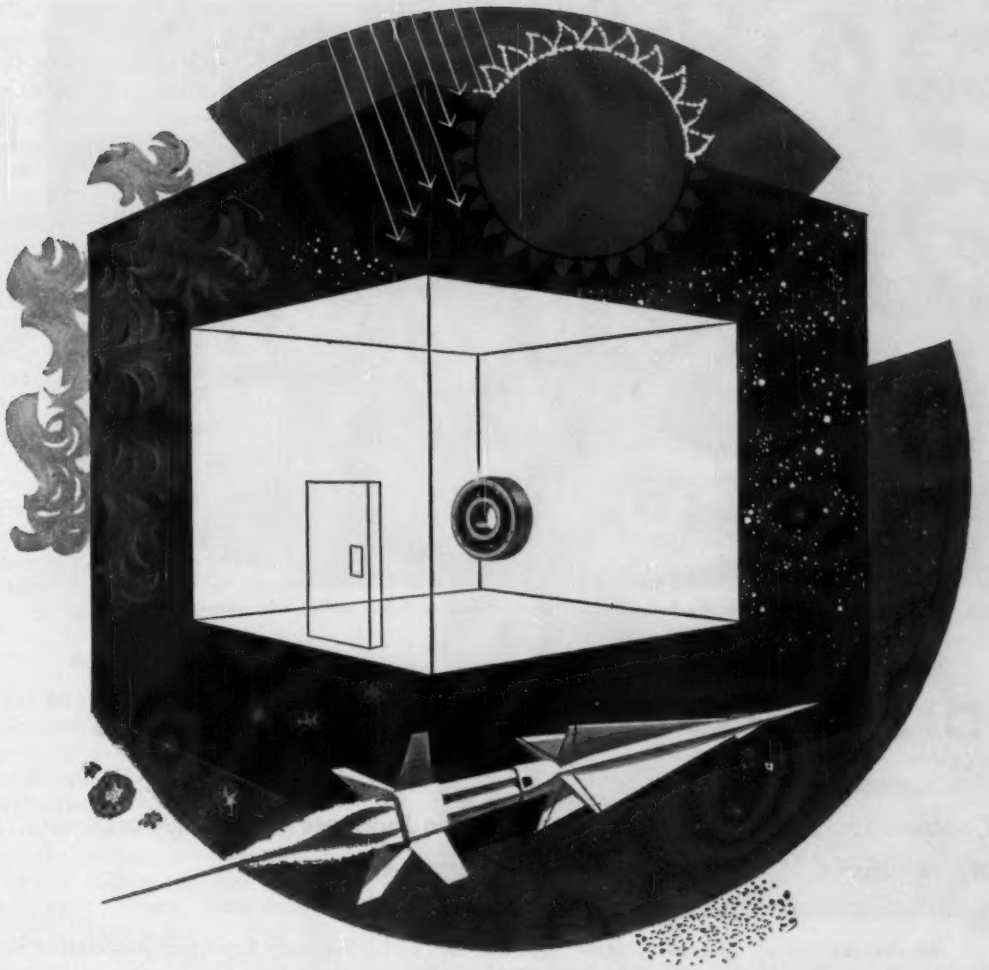

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U. S. buying of semiconductors made in Japanese factories appears likely to follow current brisk patterns

Import Curb Plea Under Fire

Counterattacks to petition for import curbs on Japanese semiconductors are registered in Washington. Possible deadlock seen

IMPORTERS of semiconductors—transistors, diodes, and rectifiers—are marshalling forces for what promises to be a long and bitter fight in Washington against curbs on foreign sales asked by Electronic Industries Association at Office of Civil and Defense Mobilization.

Electronic Industries Association filed its protest primarily against imports of transistors from Japan, and based its plea for new restrictions on the grounds that recent spurts in the importation of these products threatens domestic manufacturers whose productive capacity is vital to the national defense (ELECTRONICS, p 32, Nov. 6, 1959).

EIA, supported by a companion petition filed by Texas Instruments Inc. and affidavits from several other member companies, is seeking relief under section No. 8 of the Reciprocal Trade Agreements Act, whose so-called "national security" clause provides the procedure by which Office of Civil and Defense Mobilization can recommend import quotas or other restrictions.

According to EIA's petition, imports of Japanese transistors (and other foreign semiconductors) threaten:

- To impair the efforts of U. S. producers to provide the capacity to meet existing and potential national security requirements;
- To create instability in industry employment;
- To deprive the domestic industry of profits from entertainment transistor profits which go into expensive research and development of military-use products; and
- To deplete domestic production capacity to the point where the U. S. is dependent on foreign sources for defense needs of these products.

Rebuttal Filed

In mid-December, Japanese importers filed a sharp rebuttal to EIA's plea. The Electronics Industries Association of Japan, the Japan Electronics Export Promotion Association, and the Japan Machinery Exporters Association were later joined by the British Chamber of Commerce and a U. S. importer of German products, Robert Bosch.

The Japanese contentions are:

- That imports of entertainment transistors and transistor radios compete with domestic output of entertainment equipment only, and do not threaten the productive capacity of U. S. firms producing military-use items;
- That the bulk of Japan's exports of these items to the U. S. are shipped under patent licensing agreements with U. S. firms such as Radio Corp. of America, Transitron, Inc., and Raytheon Co.;
- That domestic leaders in the production of military-use semiconductors do not rely on profits from sales of entertainment items to finance their defense research.
- That the Dept. of Defense has advised OCDM that domestic productive capacity of semiconductor items currently is in excess of defense needs.

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What has EIA disturbed is that, according to Commerce Dept.'s latest figures, imports of Japanese transistors multiplied from $7,000 in 1958 to $521,000 in the first six months of 1959 alone.

U. S. imports of other semiconductor devices from Japan totaled $42,000 in the first half of 1959.

Nevertheless, EIA contends that, despite a 15 percent tariff, Japanese transistor imports have burgeoned in the last two years from a negligible volume to "about 25 percent" of total U. S. unit production.

The Japanese counter that their shipments are so concentrated in the nonmilitary, entertainment-item field that their U. S. sales of higher priced military items totaled a mere 2.7 percent of the domestic semiconductor dollar volume output in 1958, and an estimated 3.5 percent in 1959.

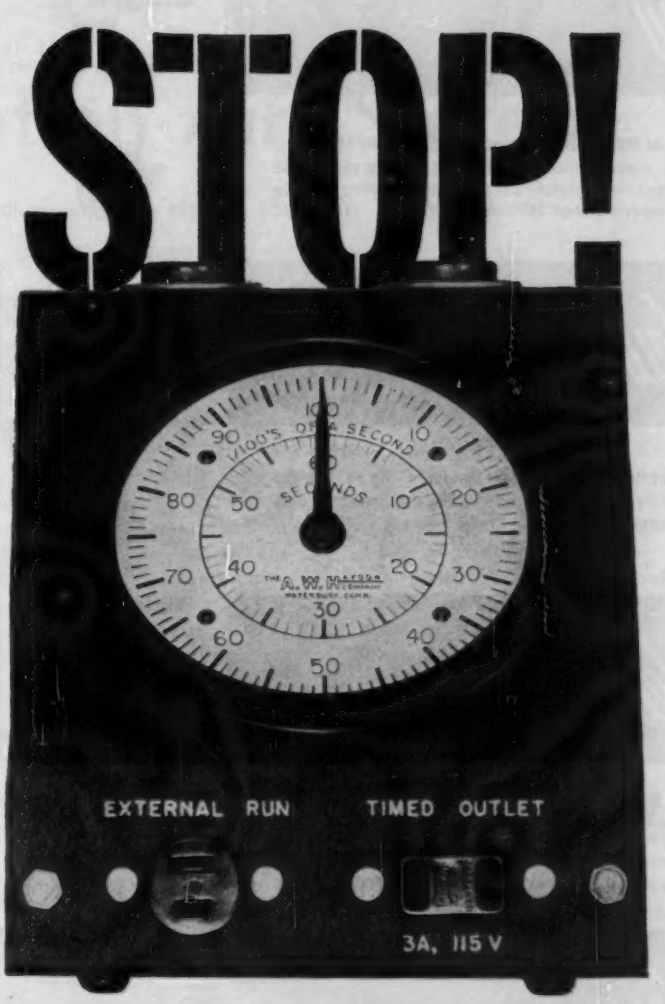
Rumors Abound

Behind the feud, the trade is rife with rumors that some U. S. producers of military-use semiconductors depend on Japanese imports of entertainment items to the point where they will refuse to support EIA, though they are members.

OCDM staffers say they want to stay out of any intraindustry wrangle. They point out that only one section No. 8 case has resulted in new curbs on imports—that one involving the mandatory quotas on petroleum. Over a dozen other similar cases have been rejected at OCDM—not because the agency has refused to accept petitioners' contentions that they are "defense-essential," but on the grounds that imports are not constituting a threat to domestic productive capacity needed for defense.

The semiconductor case may take several months to complete. But to date, the strongest indication of the rough road EIA faces is contained in the Defense Department's recent survey cited by the Japanese.

The Pentagon's Electronic Production Resources Agency reported to OCDM several months ago on the request of the National Security Council. Its finding: There is adequate U. S. capacity for production of transistors and other semiconductors to meet both current and long-range military needs.



Look what happened when A. W. Haydon designed a new LABORATORY STOP CLOCK

You just won't find these features in any other stop clock. This versatile timer-of-all-work was designed by engineers who understand timers and timing...and who needed a precise time reference in their own work. **Timed outlet**—energized whenever clock runs, supplies 115V, 60 CPS, 3 amp to time and control external loads simultaneously...manually or automatically. **External Run Socket**—for remote running, using a control cable... manually or automatically (when wired into a system). **Clutchless timing mechanism**—needs no warm-up, make-ready or pre-start. Synchronous motor starts and drives instantly. No power consumed except during timing and reset. **Independent RUN and RESET** buttons for manual, local control. **Schematic diagram** and control circuitry silk-screened on bottom of housing for ready reference. ■ Bench type precision stop clocks are available with optional remote control for manual or automatic running and/or resetting. Clocks operate on commercial 115V, 60 CPS power; accuracy is ± 25 milliseconds. Low power drain: only 2 watts, timing. Sweep second scale calibrated in 10 millisecond increments; totalizer scale calibrated in seconds, up to 1 min. Sturdy instrument case requires only 4¼" square bench space. For complete specifications, write for Bulletin ET-702. Ask also about panel-mounting versions.

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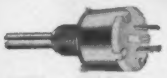

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Space Age Hi Temp Military Control, Series 600.
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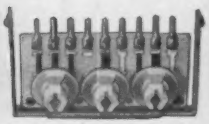
Low Cost Miniature Trimmer Pot, Series 110.
3/4" dia. preset wirewound 1/2-5,000 ohms resistance range variable resistor. Exceptional reliability due to several unique design features.

Circle No. 281

New

New



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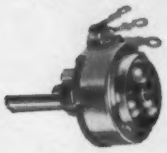
67% **Smaller Side-By-Side Printed Circuit Ceramic Base Control, Type X153.**
Compact space-saving self-supporting snap-in 2 or 3-section variable and fixed resistor network 1/3 the size of previous units designed for printed circuit applications.

Compact Vernier Variable Resistor, Type VA-45.
12-1/2 to 1 reduction. For fine tuning applications. Ball bearing rotation.



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New

New

Circle No. 284

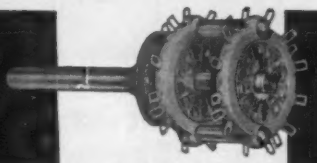
Separately Mounted Simple Design Pull-Push and Push-Push Switches, Types SK-1 and SJ.
13/16" dia. In separately mounted styles for home appliances and other electrical and electronic applications.

Higher Reliability Micro-Miniature Composition Control, Series M250.
9/32" dia. For miniature transistor hearing aids, miniature radios, telephone equipment and industrial applications requiring tiny size and exceptional reliability.

Circle No. 285

New

New



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Exceptionally high uniform reliability is achieved by an entirely new manufacturing concept. For military and commercial applications.

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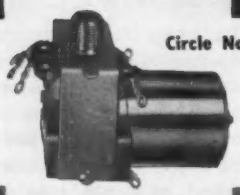
Compact Motor Driven Control, Type MD 45.
For remote control functions.



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Canadian Station Airs Stereo

Regular broadcasting of a-m stereo starts soon in Montreal as government network and other stations show growing interest

STEREOPHONIC BROADCASTING is well on its way to becoming a reality for Canada's most populated region.

Shakedown of equipment already installed at station CJAD, Montreal, is now taking place. Scheduled broadcasting is slated to start in the near future.

The system is an a-m/a-m installation which transmits stereo to listeners with two a-m receivers. To hear the stereo effect the listener must tune receivers slightly off frequency. Listeners with one radio can hear the same programs with no noticeable loss of quality.

Present plans call for broadcasts of a half-hour during the day and 1½ hours in the evening. Approval for the stereocasting has been granted by Canada's Department of Transport, whose responsibilities include communications. The license for stereocasting has been issued on an experimental basis to the Columbia Broadcasting System affiliate station. There are indications that other commercial stations in Canada as well as the government-operated Canadian Broadcasting Corp. are also interested in stereo broadcasting.

Interest Is High

Owner and president of the station, J. Arthur Dupont, told ELECTRONICS that interest seems high in stereo among Montreal listeners. The station has been keeping a close watch on sales of stereo records and stereophonic high-fidelity equipment. Based on these observations, success of the venture is anticipated.

Kahn Research Laboratories, Inc., Freeport, L. I., supplier of CJAD's stereo gear, reports that interest in stereo is not confined to Canada and the U. S. alone. The company has installed equipment in Mexico City for station XEW, which plans regular stereocasts in the near future, and in Venezuela at both of that country's two radio stations. The Venezuelan stations completed preliminary tests in the fall of last year and have since ordered more equipment.

Expectations are that stereocasting in Canada will move forward at a faster pace than in Latin America. As in the case of television broadcasting, the Latin American stations are operating in an environment where per capita ownership of radio sets is low by U. S. standards. Mexican manufacturers are producing conventional a-m receivers that sell for as low as $11, but doubt that there is as high a proportion of two-set homes in their country as there is north of the border.

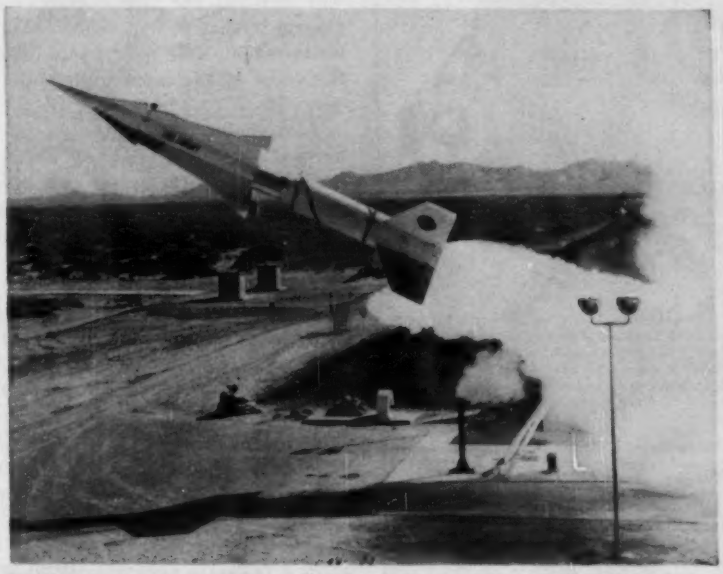
It is unlikely, however, that this factor will slow down XEW's efforts to any great extent, observers believe. They note that the station owners have a reputation for positive action.

In the early days of television, the Mexican station stimulated receiver purchases by establishing well-equipped studios, presenting a mixed fare of bullfights, baseball games and variety programs and even installing a complete pint-sized auditorium for children's shows from which parents are banished behind glass partitions.

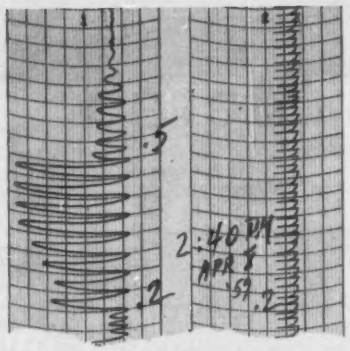
Supporters of stereophonic broadcasting in Latin America are also relying on the love of music shown by most of the people in their countries.

Leonard R. Kahn, president of KRL, says an expansion of the receiver market will follow the rise in stereo broadcasting in any country. His company has designated a two-channel a-m receiver requiring only an auxiliary speaker. "The cost and complexity of these home receivers must be minimized to assure widespread public acceptance," he said.

Nike-Zeus Antimissile Missile



R&D costs for Army's antimissile missile, Nike-Zeus, have passed $1½ billion. Congress will decide if the weapon will go into production. Prime contractor Western Electric is responsible for the radio command guidance system



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...and with today's accelerating technology, the need for the most accurate time reference available becomes more acute. It *is* available ...and free; the standard time and frequency transmissions of the National Bureau of Standards radio stations WWV and WWVH are accurate to better than 1 part in 50 million and are placed at the disposal of anyone having a receiver capable of tuning to one or more of the transmitting frequencies.

The new Model WWVT receiver, designed especially for remote operations under extreme environmental conditions, is a highly-sensitive crystal-controlled instrument capable of utilizing WWV and WWVH transmission.

Model WWVT

A 6-position dial switches *instantly* to any Standard Frequency — 2.5, 5, 10, 15, 20 or 25 mc. It is small, light-weight and rugged — sealed metal case and potted components, all transistorized and battery operated, and has better than 2 mv sensitivity. Priced at $545.00

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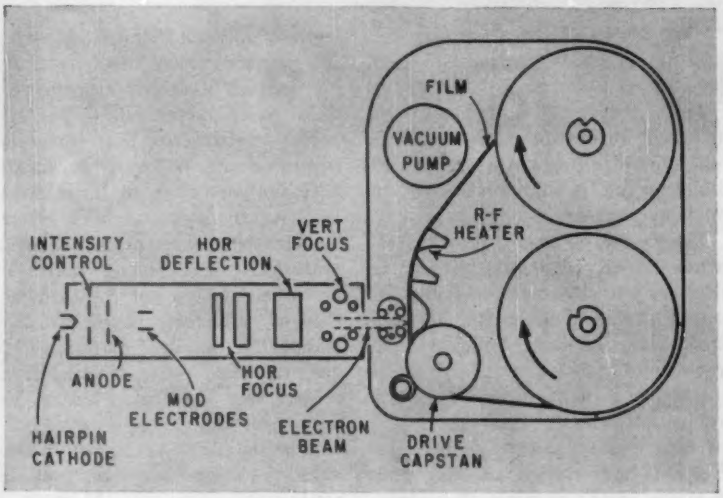
New System Stirs

Information storage on heat-sensitive tape is provoking a number of serious questions. New developments are being closely watched



Experimental thermoplastic tape recorder drives film at constant speed. Specially designed electron gun produces charge, records color or b&w

THERMOPLASTIC RECORDING of television signals and its effect on users of magnetic tape continues to monopolize a good many conversations this week for both business men and engineers.

Of interest to the engineer is the way in which the tape operates and the equipment it will require. The businessman asks how it will affect the value of the tape equipment he now owns.

Technically, the "thermotape" process may be defined as a system for storing information at high density on a film containing a plastic coating which melts at low temperatures.

Information is placed on the tape with an electron beam in such a way as to permit electronic playback of tv images in black-and-white or NTSC simultaneous color, or of computer input data. In a system described by General Electric this week in New York, the feasibility of producing direct optical images from the thermotape was discussed.

Action of the electron beam lays down a negative charge pattern on the plastic film. Attraction of a positive back plate for the negative charges causes depressions when plastic is heated. The pattern is fixed for storage by subsequent cooling.

For storage of color images, deformation ridges are impressed as phase diffraction gratings whose spacing and amplitude determine the color features. The gratings are produced through velocity modulation of the horizontal sweep of the electron beam by two low amplitude r-f carriers. These carriers are fed to the beam producing gun from an external modulating circuit. Two carriers are applied to the horizontal deflection plates of the gun. Another carrier is applied to the modulator electrodes. This carrier modulates the vertical deflection. Gratings spaced 10 microns center-to-center have been obtained.

Video readout is accomplished by a special optical system in combination with a conventional flying spot scanner or camera tube. Direct optical readout is possible with another type of specialized optical system.

To erase, the charge pattern is removed by raising the temperature of the film high enough above its

Tape Users

melting point to increase conductivity as well as soften the film.

George I. Long, president of Ampex Corp., says his company has also been conducting research in this field for some time. A bulletin on the thermotape method as well as other storage techniques was published by Ampex in September of last year. Company spokesmen told ELECTRONICS there is no great worry over competition from thermotape. They see it as a future adjunct rather than a competitor to their product.

One indication that there will be no great upset in present tv tape usage lies in the fact that there are presently some 700 magnetic tv tape recorders operating in this country. These units range in cost from $52,000 to $71,000. Talks by ELECTRONICS with tv stations, and tv advertising tape producers show a reluctance to start thinking about replacement of their equipment in the foreseeable future. Comment from one major network was "Our people are just getting settled to the existing system and aren't going to start looking for something new for quite a while."

Industrial users are showing a "Wait and see" attitude. Questions have been raised over the reliability of the reused thermotape in view of the fact that it must be deformed during recording.

A company engaged in manufacture of airborne equipment expresses doubt that there will be much application at this time for thermotape in satellite and missile programs.

Manufacturers of magnetic tape do not seem to be overly worried about potential competition arising from the new tape. Minnesota Mining & Manufacturing, for example, is prepared to pick up the ball and run if the play goes in that direction, but reminds that its highly diversified line is not likely to be hurt by any innovations.

Reeves Soundcraft, which launched a new division to produce commercial video tape this month feels confident that its predictions for a $10-million market will not be impaired by thermotape.

CIRCLE 47 ON READER SERVICE CARD→

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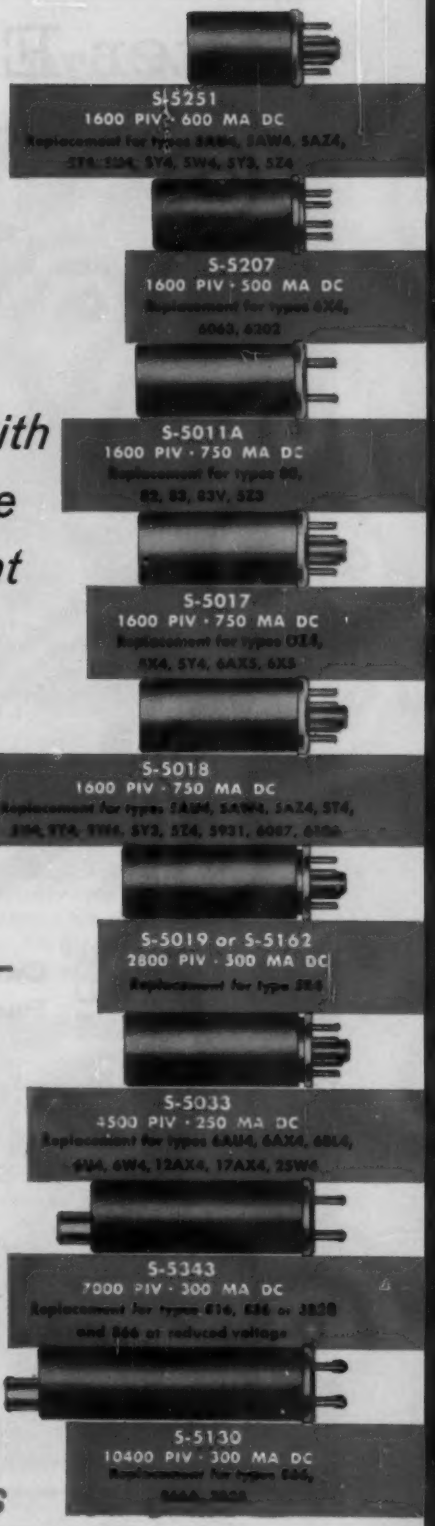
over 95% of all popular rectifier tube types can be replaced with Tarzian tube replacement silicon rectifiers

ultimate reliability, small size—with excellent efficiency—are some of the many Tarzian plus values



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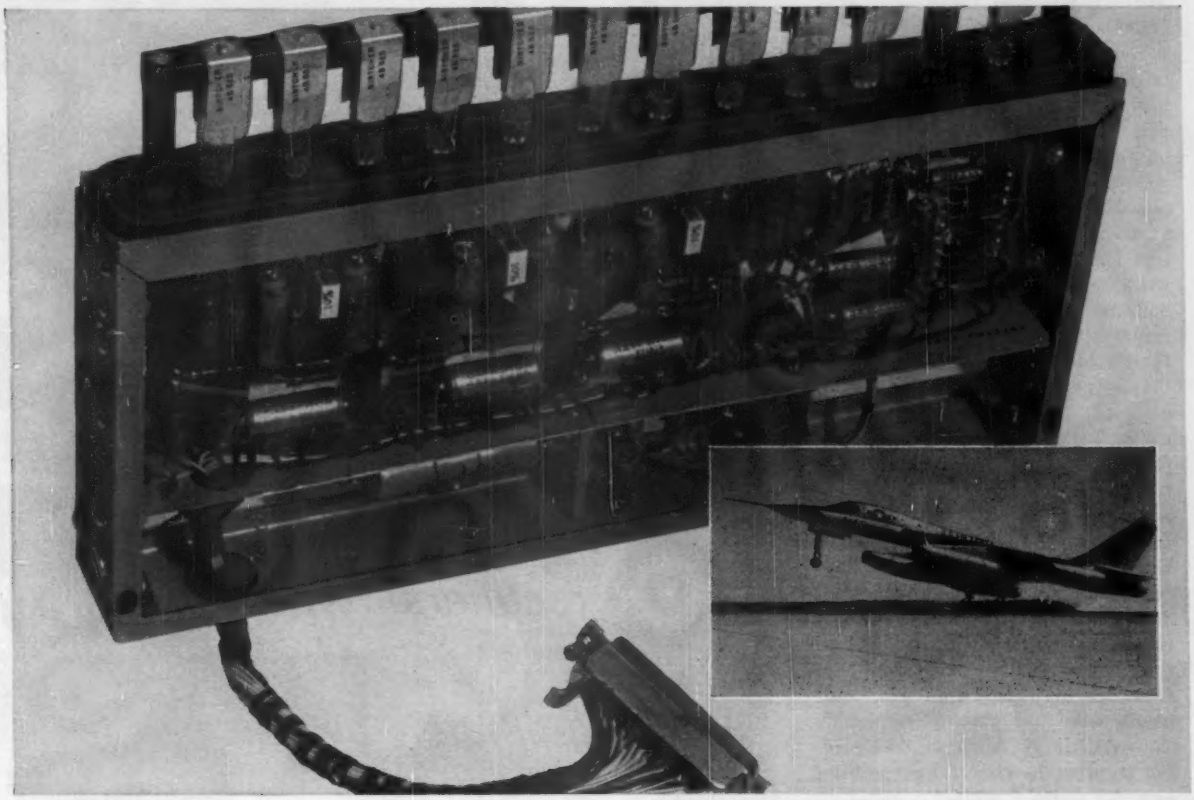
SILICONE NEWS from Dow Corning

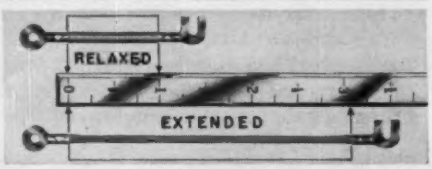
Better Environmental Design



SILASTIC® Cushions Electronic Packages at -90 to 250C

Where environmental conditions are extreme, or fluctuate from one extreme to another, specify resilient Silastic® to protect sensitive components. Silastic, the Dow Corning silicone rubber, is not affected by temperatures from —90 to 250 C (—130 to 500 F), nor by rapid thermal cycling. It retains its excellent dielectric and physical properties . . . resists the effects of ozone, storage, moisture, corona.

For these reasons, Silastic was selected by engineers of the Emerson Electric Manufacturing Company, St. Louis, for several parts of the electronics package shown. Part of the fire control system on Convair B-58 Mach 2 bombers, this unit must function at —65 F . . . continue to function dependably despite vibration and operating temperatures up to 350 F around the miniature tubes. A molding of heat resistant Silastic holds the tubes gently but firmly to protect them from vibration and shock. Silastic grommets, feed-throughs, and connector insulation are also part of the package. In any climate and under any environments, Silastic gives required protection to Emerson's assemblies.



Wire That STRETCHES

Like a stretch-to-fit sock, this snappy new product extends itself to meet your needs. Available with insulation of Silastic, it is called Stretch Wire, and is manufactured by the Stretch Wire Corporation.

Stretch Wire elongates to 165% of its original length . . . then springs back. It has already proven itself in missile and ordnance electronics, withstanding launchings at speeds of 1000 fps and inertia loads of 800 G's. Because of the properties of Silastic, the insulating sheath remains elastic under the temperature extremes encountered.

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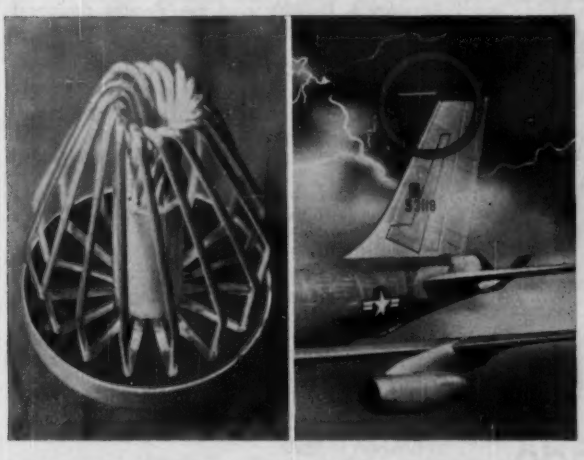


Laminate Parries Lightning Thrust

Long range HF communication systems employing probe-type antennas are now safe from lightning strikes with the new Aircraft Lightning Arrester made by Joslyn Manufacturing and Supply Company, Chicago.

Key component: a 0.0625 inch thick slotted silicone-glass laminate part that serves as retainer and insulator for 15 phosphor bronze spring elements. Made of Dow Corning silicone resins and glass cloth, this part enables the arrester to safely discharge lightning strokes with a peak current of 100,000 amperes and 200 coulombs charge. The silicone laminate is strong, resists moisture, vibration and fungus growth, and is inexpensive to fabricate. Electric strength is . . . obviously . . . excellent.

CIRCLE 253 ON READER SERVICE CARD

New Gel Gives "View-Through" Protection

Poured as a liquid, transparent Dow Corning Dielectric Gel fills all voids, then sets up to form a heat stable gel. Dielectric strength is excellent; stress on components almost nil. Potted components and circuitry remain clearly visible . . . can be checked by eye. Probes can be inserted for instrument checks . . . the gel re-seals itself when probes are removed. Individual components can be removed and replaced.

Dielectric Gel enabled CBS Laboratories to meet stringent reliability requirements on its Photoscan power supplies. Despite high temperatures, high voltages, and high vibration levels in this remarkably small unit, Dielectric Gel prevents arcing. Components are spaced less than 1/4" apart, yet output voltages run from 1,000 to 25,000 volts!

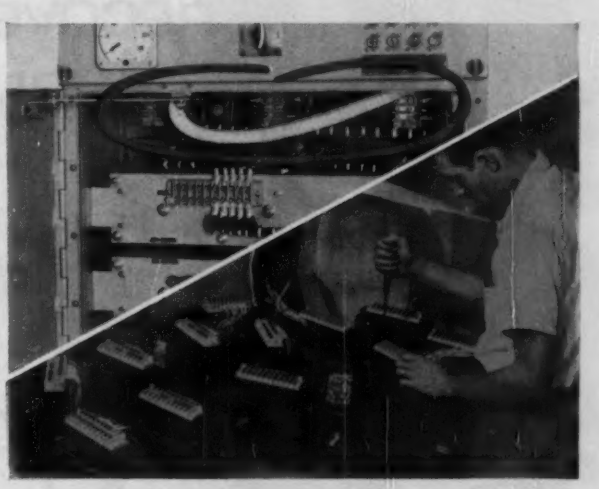
CIRCLE 254 ON READER SERVICE CARD

997 Varnish Ups Power, Cuts Weight

When designing transformers to operate at high temperatures in standby control power supplies for submarine nuclear reactors, Milro Controls Co. faced three major musts: maximum power output for minimum weight; great resistance to moisture; ample overload protection.

Impregnating with Dow Corning 997 Varnish, and using silicone insulating components, proved to be the right answer on all three counts. This silicone varnish withstands operating temperatures up to 250 C . . . provides superior protection against all the well-known enemies of electronic and electrical equipment. Each of the new Milro power supplies contains three compact, light-weight transformers, impregnated with 997.

CIRCLE 255 ON READER SERVICE CARD



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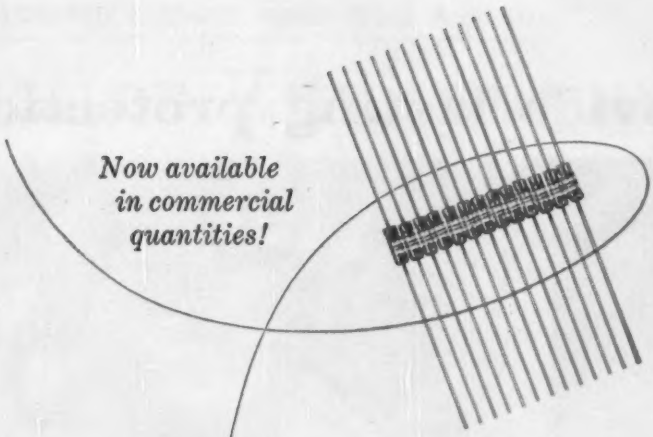

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SYLVANIA D-1820 is the forerunner of an outstanding family of diodes, designed, produced and controlled specifically for logic circuitry. The cost of this new SYLVANIA diode is low enough to make it especially attractive for use in quantity-produced electronic computers. SYLVANIA D-1820, and the circuits designed around this diode, feature:

high-speed operation — with recommended circuits, all units are guaranteed to provide a maximum recovery time of 4 millimicroseconds. However, recovery times of 2.5 millimicroseconds are typical.

long-life performance — proved in 1000-hours operating and 7000-hours storage life tests.

high reliability — basic point-contact structure has been field-proved for more than a decade. Withstands environmental conditions of shock and vibration.

exceptional uniformity of electrical characteristics—assures complete interchangeability within the type—result of modern automated-production techniques employed in the manufacture of SYLVANIA D-1820.

economy — SYLVANIA pioneered the field of germanium point-contact diode manufacture, has "know-how" of superior-quality, large-quantity economical production. SYLVANIA is able to pass these savings on to you.

simplicity—diode-logic circuitry is relatively uncomplicated, requires few components. It reduces computer construction costs. It adds to equipment reliability.

compactness—SYLVANIA D-1820 "package" is miniature all-glass.

availability—units can be supplied immediately through your local Sylvania Semiconductor Distributor or through your local Sylvania Field Office.

Complete sales information on quantity prices, delivery and sampling for your own evaluation is available from your local Sylvania Semiconductor Distributor or Field Office. For engineering data sheets on the new Sylvania D-1820 High-Speed Switching Diode or on any Sylvania Semiconductor Device, write Sylvania Semiconductor Division, Dept. 22-1, Woburn, Mass.

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Absolute Maximum Ratings*		Typical Operating Conditions*	
Fwd. Volt	1.3 V†	Fwd. Volt	0.9 V
Fwd. Curr.	50 mA	Fwd. Curr.	2.0 μA
Back Volt	20 V	Rev. Recovery	2.5 mμs
Pwr. Diss.	80 mW		

†at 10 mA *at 20° C.

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Soviets Spur Tv Set Output

USSR plans to triple production to 3½ million sets a year by 1965. New standards decreed

DESPITE emphasis on consumer goods, the USSR seven-year economic plan will make little dent in the U. S. production and design lead in home television sets.

The Soviets plan to triple tv receiver production from the present rate of 1,200,000 sets a year to about 3½ million in 1965 when the plan ends. By then, an estimated 18 million tv sets will be in operation.

Information comes from B. A. Berlin, of the USSR state committee on radio-electronics, who recently presented a paper before the British Institute of Radio Engineers' convention on tv engineering.

Soviet tv set production falls largely into three categories: 21-in. high-quality sets, 17-in. medium quality sets and cheaper sets up to 14 in. The first two have f-m sound. Luxury models are produced only in limited numbers.

Better quality Soviet sets have automatic frequency control and stabilization circuits. Principal new design trends in production models are: (1) introduction of automatic frequency control for tuners and (2) replacement of 70-degree picture tube designs by 110-degree tubes.

The design standards, which follow by years the U. S. and Western European lead in this field, have been recently specified by Communist Party decree along with other goals of the seven-year plan (ELECTRONICS, p 34, Nov. 29, '59).

In addition, the party has called for the establishment of special design offices at major plants producing consumer articles. Observers in Moscow generally believe that this is at least partly the result of Khrushchev's U. S. visit and the impact of the American exhibition in Moscow last summer.

New Look in Sets

The party decree deplores heavy, uneconomic design of household goods. It calls for use of plastic cases instead of wood for transistorized radio sets, phonographs, tv sets and tape recorders. It also appears that longstanding complaints of Soviet citizens about the lack of repair facilities for tv sets are being answered with a party order for the "organization" of tv repair shops.

Report on television broadcasting was given the Supreme Soviet by communications minister Nikolay Psurtsev. He said 84 tv centers are now operating. Thirteen of them were commissioned just before the end of 1959, thus extending broadcasts to all capitals of union republics and other cities with a total population of 75 million.

The minister reported that 60 tv stations out of 100 envisaged in the seven-year plan are under construction. He indicated that programs would be exchanged with other Communist countries by the end of the plan. He was non-committal on color tv, stating only that "much attention is being paid" to its development and that trial transmissions have begun in Moscow.

Identifying Wires

Portable current-path verifier, built by Boeing for aircraft applications, identifies individual wires in seconds in the complex wiring of B-52G bomber. Two small batteries supply power to 5-lb unit in use at firm's Wichita division

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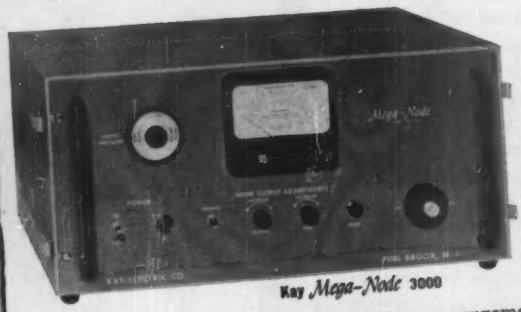
A COMPLETE RANGE of RANDOM NOISE SOURCES and NOISE GENERATORS, 1 KC–26,500 MC

for

Measurement of Receiver Gain, Indirect Calibration of Standard Signal Sources, Measurement of Noise Figure



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Your specific needs for noise figure measurement can be met by one or more instruments from the Kay Electric Company's comprehensive range of six instruments and 17 Microwave Assemblies.

Instrument & Cat. No.	Frequency Range (mc)	Noise Figure Range (db)	Output Impedance (ohms)	Price*
Mega-Node 240-B	5-220	0-16 at 50 ohms 0-23.8 at 300 ohms	unbal.—50, 75, 150, 300, ∞ bal.—100, 150, 300, 600, ∞	$365.00
Mega-Node 175-A	50-500	0-19	balanced—300	$365.00
Mega-Node 403-A	3-500	0-19	unbalanced—50	$790.00
Mega-Node- 3000	10-3000	0-20	unbalanced—50	$1495.00
Rada-Node 800-A	5-400	0-23.8 depending on impedance	unbalanced as specified	$1965.00
	10-3000	0-20	unbal. nom. 50	†
	1120-26,500	15.28 or 15.8	waveguide	$495.00
Thermo-Node	Head A 2-1000 mc	10	50	$125.00
	Head B 1 kc - 400 mc		50	$125.00
	Head C .25 - 400 mc		Selectable 50, 100, 200	$125.00

†With Microwave Mega-Nodes as Accessory — prices below

Microwave Mega-Nodes — argon, neon and fluorescent gas discharge tubes. Noise output of 15.8 ± 0.25 db for fluorescent tubes; 15.28 ± 0.1 db for argon. Fluorescent tubes equipped with thermometer for correction factor of —0.05 db per degree above 32° C. No correction required for argon tubes. Supplied with power cables and fittings. Power Supply for any waveguide size: $95.00.

Waveguide Type AN	Flange AN	Frequency mc.	Catalog No. Argon	Catalog No. Fluor.	Price*
RG-69/U	UG-417/U	1120-1700	**	312-A	$595.00
RG-69/U	UG-417/U	1200-1400	311-A	310-A	$395.00
RG-104/U	UG-435/U	1700-2600	**	870-A	$495.00
RG-112/U	UG-553/U	2200-3300	**	880-A	$495.00
RG-48/U	UG-214/U	2600-3900	261-A	260-A	$175.00††
RG-49/U	UG-149/U	3900-5850	271-A	270-A	$175.00††
RG-50/U	UG-344/U	5850-8200	281-A	280-A	$175.00††
RG-51/U	UG-51/U	7050-10,000	291-A	290-A	$175.00††
RG-52/U	UG-39/U	8200-12,400	301-A	300-A	$175.00††
RG-91/U	UG-419/U	12,400-18,000	521-A	**	$250.00
RG-53/U	UG-425/U	18,000-26,500	531-A	**	$250.00

†† Any three plus power supply: $595.00. Any in excess of three: $167.00 ea.
** None available.

Write for new Kay Catalog

*All prices f.o.b. factory.

KAY ELECTRIC COMPANY

DEPT. E-1 **Maple Avenue, Pine Brook, N. J. CApital 6-4000**

CIRCLE 53 ON READER SERVICE CARD→

RARE COMBINATION OF RELAY SPECS

SIGMA SERIES 32 — POLARIZED, DPDT MAGNETIC LATCHING RELAY

50 mw. sensitivity
current operated
30 g to 5000 cps
vibration immunity
100 g shock immunity

SIGMA

SIGMA INSTRUMENTS, INC.
36 Pearl St., So. Braintree 85, Mass.
An Affiliate of The Fisher-Pierce Co. (since 1939)

That artistic square wave is here to suggest but one of the application virtues of Series 32 relays: operation on nothing more than the meager energy of a single, short pulse. And with magnetic latching, the need for standby power and return springs is eliminated. The "32" is also a true *current*-sensitive relay, designed and built to operate cleanly when a slowly increasing current reaches the operate value. Contact closure is fast, positive and synchronous. And in common with most polarized relays, the dual-coil version of the "32" operates on the algebraic sum of the currents in its windings — making it ideally suited to comparing a variable signal current to a reference current.

The specs published here all include safety margins and understate the "32's" actual capabilities. And better than the printed word, they hold true in customers' circuits. Further data will be sent in answer to letterhead requests.

(See reverse side for major specifications)

MAJOR SPECIFICATIONS

Sigma Series 32 Subminiature Relay

(See reverse side for basic design & application characteristics)

OPERATION Double-pole double-throw, either-side stable, polarized magnetic latching (Sigma Form Z). Depending on the polarity of coil signal, the armature latches magnetically in either of two fixed positions. There is no center-off position. The coil signal may be ONE current flowing in one coil, two coils in series or two coils in parallel; or the operating coil signal may be the algebraic sum of the currents in each coil.

SENSITIVITY Operate 50 mw. single-coil, 100 mw. each coil of dual-coil version.

VIBRATION 30 g to 5,000 cycles per second with no contact opening (with relay energized or de-energized).

SHOCK AND CONSTANT ACCELERATION 100 g will not cause damage and there will be no contact opening (with relay energized or de-energized).

THERMAL STABILITY Relay remains within specification over an operating temperature range of − 65°C. to +125°C. See curve, Fig. 1.

CONTACT RATING 2 amperes at 28VDC/120VAC, resistive load, for a minimum of 100,000 operations at +125°C maximum, based on silver contact material. Gold alloy contacts recommended for dry circuit applications.

CONTACT RESISTANCE 50 milliohms, max. before use; 100 milliohms max. after 100,000 operations at rated load.

TIMING CHARACTERISTICS Relay operate time depends largely on the nature of the energizing circuit, mainly in terms of effective source voltage and final steady state coil current. Operate time varies inversely with both current and voltage overdrive. See timing curves, Fig. 2.

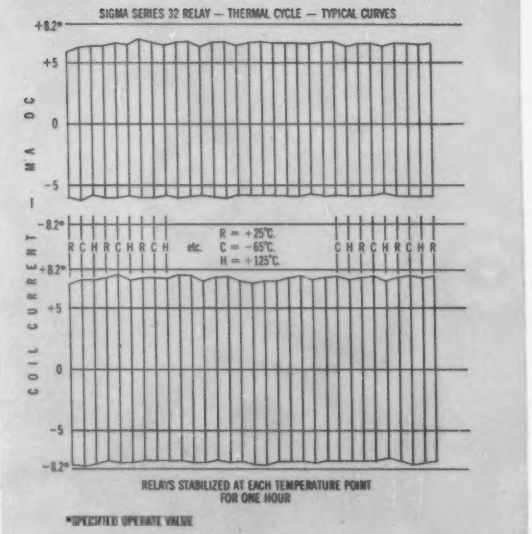

SIGMA SERIES 32 RELAY — THERMAL CYCLE — TYPICAL CURVES
+8.2°
+5
0
−5
−8.2°
COIL CURRENT — MA DC
R C H R C H R C H etc.
R = +25°C.
C = −65°C.
H = +125°C.
C H R C H R C H R
RELAYS STABILIZED AT EACH TEMPERATURE POINT FOR ONE HOUR
*SPECIFIED OPERATE VALUE

Fig. 1.

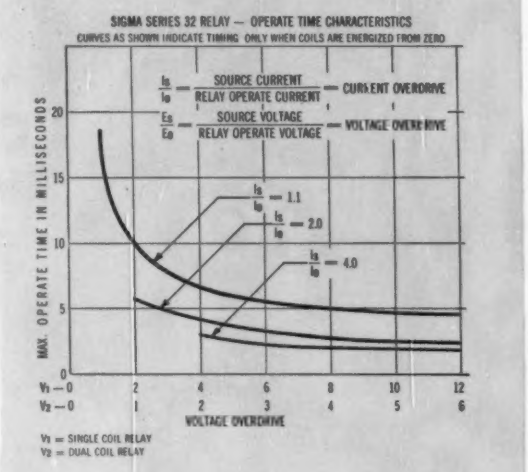
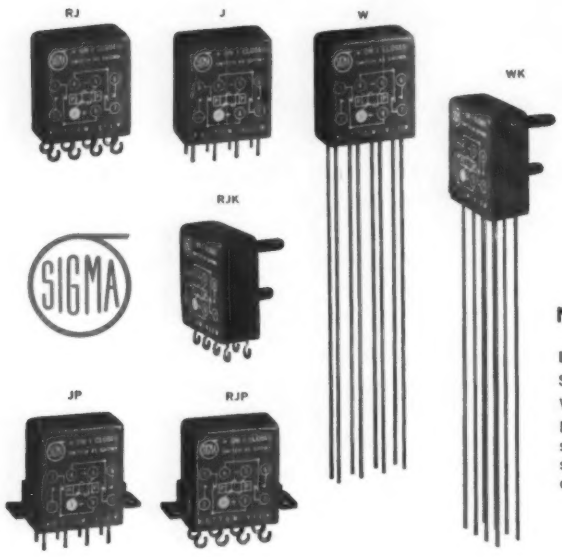
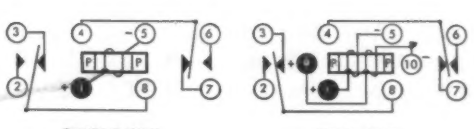

SIGMA SERIES 32 RELAY — OPERATE TIME CHARACTERISTICS
CURVES AS SHOWN INDICATE TIMING ONLY WHEN COILS ARE ENERGIZED FROM ZERO
Is/Io = SOURCE CURRENT / RELAY OPERATE CURRENT = CURRENT OVERDRIVE
Es/Eo = SOURCE VOLTAGE / RELAY OPERATE VOLTAGE = VOLTAGE OVERDRIVE
MAX. OPERATE TIME IN MILLISECONDS
Is/Io = 1.1
Is/Io = 2.0
Is/Io = 4.0
V1 — 0
V2 — 0
VOLTAGE OVERDRIVE
V1 = SINGLE COIL RELAY
V2 = DUAL COIL RELAY

Fig. 2.





MECHANICAL DATA

ENCLOSURE Hermetically sealed.

SIZE .800" x .400" x .900" high (0.288 cu. in.)

WEIGHT 18 grams (0.63 oz.)

MOUNTING STYLES AND CONNECTIONS All pins spaced on 0.100" grid. Dimensions are the same for single- or dual-coil versions; only the pin configurations differ.

SIGMA

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An Affiliate of The Fisher-Pierce Co. (since 1939)

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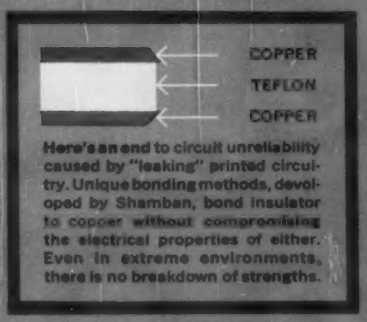
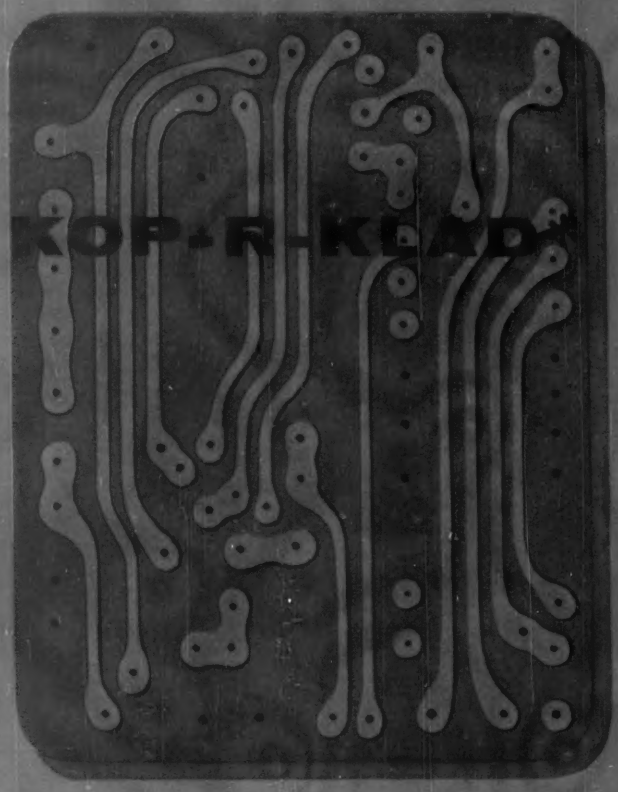
←CIRCLE 54 ON READER SERVICE CARD

CIRCLE 55 ON READER SERVICE CARD 55

NOW SHAMBAN KOP-R-KLAD* printed circuit laminate



Here's an end to circuit unreliability caused by "leaking" printed circuitry. Unique bonding methods, developed by Shamban, bond insulator to copper without compromising the electrical properties of either. Even in extreme environments, there is no breakdown of strengths.



*Tradename of W. S. Shamban & Co.

A new, complete line of hi-temperature hi-dielectric strength laminates featuring:

* Maximum electrical properties
* Unique, optimum-performance bonding methods
* Highest commercial peel strengths
* Availability in sheets and continuous lengths
* Full range of types of constructions, sizes

New Shamban KOP-R-KLAD laminate presents several distinct advantages to the users of printed circuitry. KOP-R-KLAD offers a *complete line*, the right constructions for every application; *optimum electrical properties through proper bonding*, best volume, surface and insulation resistivity, highest dielectric strength; *highest peel strength*, for sharp bends, rugged environments; *continuous lengths*, for convenience of user, for wider application. KOP-R-KLAD is available in twelve different types, including copper to Teflon, to Teflon-glass, to Kel-F, and to FEP-fluorocarbon. Each type has specific advantages, all types have the advantage of absolute dependability and predictability within the limitations of the materials specified. KOP-R-KLAD is immediately available, dependent upon type, in widths up to 36", in lengths from 2" to continuous rolls. *Write or wire factory for complete data.*

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Teflon and Nylon spaghetti tubing, standard and Microthin wall sizes. Available in all sizes, to meet every tubing need. Consistent quality.

Locating Undersea Oil Lines

Six-foot, 200-lb detector finds buried flowlines, avoids damage during new drilling

Metal detector "fish" and recording gear are used by Shell Development Co. in Louisiana off-shore oil drilling

OFF-SHORE OIL operations involving a network of 350 buried undersea flowlines led to the development of a new six-foot, 200-lb electronic metal locator by the Shell Development Co., Houston, Tex.

The company found that the maze of undersea lines, which carry oil from producing wells to production platforms, presented a constant danger of breakage in the placing of a well jacket on a new off-shore drilling site. The firm designed the locator to find areas clear of such lines.

Generates Field

The instrument generates an electromagnetic field which is disturbed when a pipeline or other metal object is within range. Aboard the ship, from which the "fish" is launched, a recorder makes a permanent record of ferrous metal objects detected. Gear is calibrated to permit operators to determine depth of buried objects.

Three-inch pipelines have been spotted at six feet under silt, says the company, but most underwater lines are less than six feet below the ocean floor.

The oil company believes the locator may also be useful in some types of marine salvage work. Shell has contracted with F. H. Maloney Co., Houston, to manufacture and distribute the locators.

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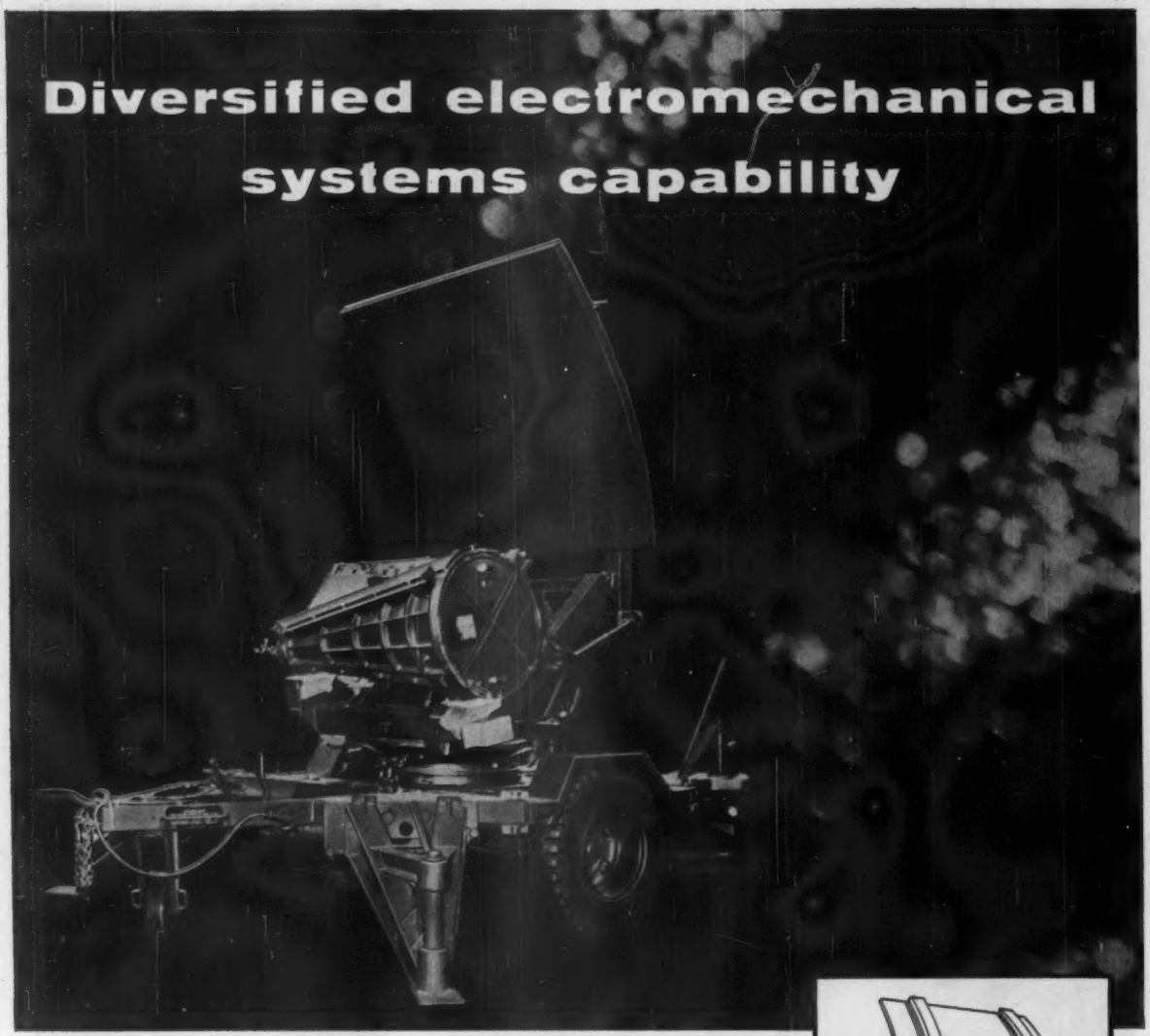

U.S. Army Signal Corps ground portable radar unit operated with two AiResearch electromechanical actuation systems.

AiResearch Actuation Systems For Portable Radar represent a typical electromechanical systems application in ground support equipment. Two types of AiResearch actuation systems are now in production for the Army's mobile trailer-mounted ground radar unit. They consist of a manually operated antenna folding storage system and an electrically powered antenna elevation system.

Designed to operate under the most severe environmental conditions, this type of electromechanical system can operate on 60 cycle A.C., 400 cycle A.C., or 28 volt D.C. Other suggested applications include: *missile launchers, missile ground handling and support equipment, armored vehicle fire control and ballistic handling systems, and mobile communications equipment requiring servoed actuating systems.*

AiResearch leadership in the development and production of electromechanical equipment for aircraft, ground handling, ordnance and missile systems of all types also includes such recent examples as spoiler servo control systems, magnetron and Klystron tuning devices, and safe-arm mechanisms for missile igniting. We invite you to submit a problem statement of your electromechanical requirements.

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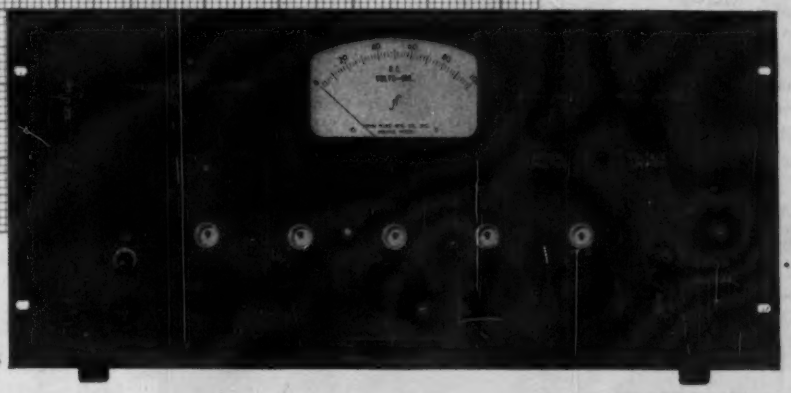

MODEL **351A**

A general purpose laboratory instrument...

The Model 351A will satisfy the most exacting requirements for accuracy and stability. This is achieved by an advanced circuit design incorporating electronic regulation plus chopper stabilization against a standard cell reference.

DIRECT IN-LINE READOUT WITH ILLUMINATED DECIMAL POINT

SPECIFICATIONS

Output Current:	0-100 milliamperes in 1 microampere steps
Output Voltage:	100 volts maximum
Voltage Limiter: (Panel Switch Selected)	Provides maximum protection for meter calibration. Limiter in: output voltage will not rise above 600 mv. Limiter out: over voltage protection places instrument in standby condition when output voltage attempts to rise above 120 v.
Output Polarity:	Floating or negative grounded
Regulation vs. Line:	0.01% or 0.1u amp., whichever is greater, for10% line voltage change
Regulation vs. Load:	0.01% or 0.1u amp., whichever is greater, for load change from zero to maximum
Calibration Accuracy:	0.05% or 0.5 uamp., whichever is greater
Current Resolution:	1 microampere
Stability:	0.005% per hour after short warm-up, 0.01% per day
Price:	$845.00, f.o.b. Seattle, Washington

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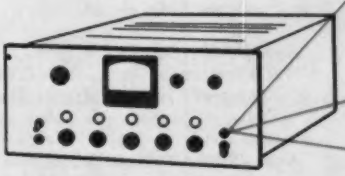
8¾" rack panel, 19" wide, 14" deep



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CIRCLE 59 ON READER SERVICE CARD

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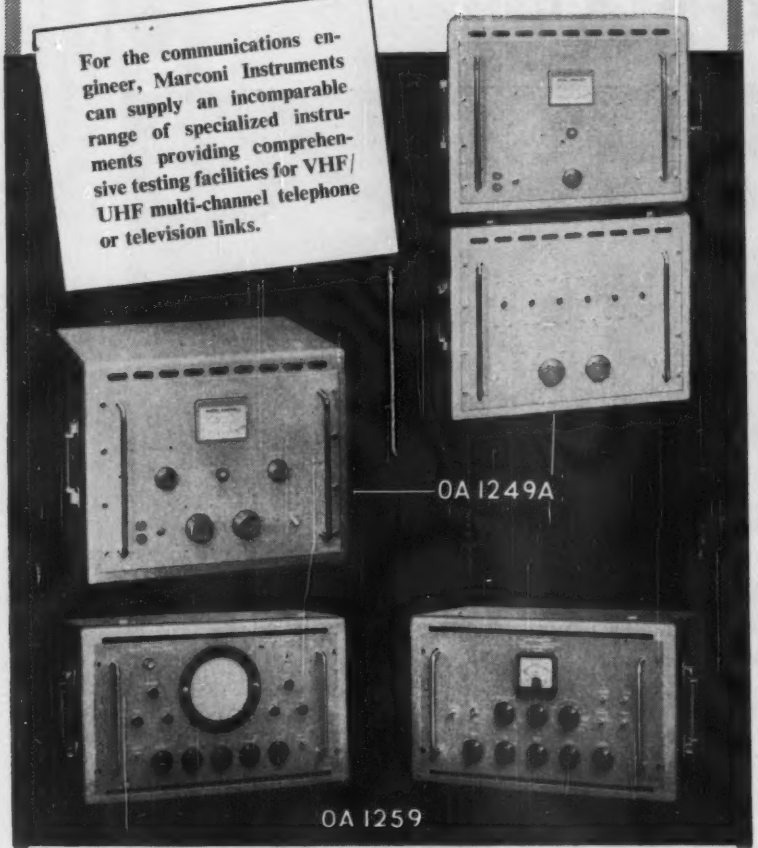
For the communications engineer, Marconi Instruments can supply an incomparable range of specialized instruments providing comprehensive testing facilities for VHF/UHF multi-channel telephone or television links.



WHITE NOISE TEST SET
OA 1249A

Measures baseband intermodulation and noise in multi-channel link equipment. Suitable for radio or coaxial systems operating 60, 120, 240, 600 or 960 channels. Measurement by noise-in-slot technique simulates busy traffic conditions.

DERIVATIVE TEST SET
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For fast and accurate linearity adjustments on multi-channel link modulators and demodulators. Generator sweeps ± 20 mc on i-f center frequencies from 65 to 75 mc. Oscilloscope unit displays 1st derivative—or slope—of response against instantaneous i-f.

MARCONI INSTRUMENTS

We will gladly mail you literature giving full details of Marconi multi-channel link test equipment—please ask for leaflets B144.

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MEETINGS AHEAD

Jan. 31-Feb. 5: Comparison of Control Computers, Winter General Meeting, AIEE, Statler Hilton Hotel, New York City.

Feb. 1-4: Instrument-Automation Conf. and Exhibit, ISA, Sam Houston Coliseum, Houston, Tex.

Feb. 3-5: Military Electronics, Winter Convention, Biltmore Hotel, Los Angeles.

Feb. 10-12: Solid-State Circuits Conf., AIEE, IRE, Univ. of Penn., Hotel Sheraton, Philadelphia.

Feb. 11-13: Electronic Representatives Assoc., Annual Convention, Drake Hotel, Chicago.

Feb. 16-18: Nondestructive Testing of Aircraft and Missile Components, Southwest Research Institute, Hilton Hotel, San Antonio, Tex.

Feb. 20-29: Component Parts and Electronic Tubes, International Exhibition, Porte de Versailles, Place Balard, Paris.

Mar. 2-24: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

Apr. 3-8: Nuclear Congress, EJC, PGNS of IRE, New York Coliseum, New York City.

Apr. 11-14: Weather Radar Conference, American Meteorological Society and Stanford Research Institute, San Francisco.

Apr. 18-19: Automatic Techniques, Annual Conf., ASME, IRE, AIEE, Cleveland-Sheraton Hotel, Cleveland.

Apr. 19-21: Active Networks & Feedback Systems, International Symposium, Department of Defense Research Agencies, IRE, Engineering Societies Bldg., N. Y. C.

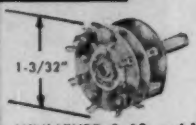
Apr. 20-22: Southwestern IRE Conf. & Electronics Show, PGME of IRE, Shamrock Hilton Hotel, Houston, Tex.

Aug. 23-26: Western Electronic Show and Convention, WESCON, Ambassador Hotel & Memorial Sports Arena, Los Angeles.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 112.

EVERYTHING IN Low-Power Switches

ROTARY



MINIATURE: 8, 10, and 12 positions; up to 18 contacts per wafer.
Series A

SMALL: Up to 12 positions in phenolic, Mycalex, or steatite insulation.
Series F

ADAPTABLE: 8, 10, 12, and 14 positions; many variations; economical.
Series J, K, N

GENERAL PURPOSE: Up to 12 positions; 30°, 45°, 60° throw.
Series H

LOW COST: Up to 12 positions; staked or strut screw construction.
Series QH

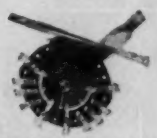
18-POSITION: Single or double eyelet fastening of clips.
Series L

24-POSITION: 15° throw handles complex circuits.
Series MF

LOW COST: 2 to 5 positions; fits in limited space.
Series 50, 53

SIMPLE SWITCHING: Up to 5 positions combined with AC switch.
Series 52, 54

SIMPLE SWITCHING: Up to 4 positions; numerous variations.
Series 20



LEVER OPERATED: 2 to 5 positions; numerous versions using std. wafers.
Series 185

CONCENTRIC SHAFTS: Dual and triple shafts with many wafer types.

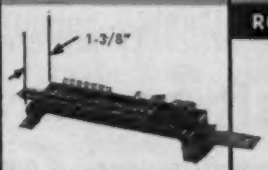
FOR PRINTED CIRCUITS: Special lug designs for direct insertions.

Endless Variety from Standing Tools

SOLENOID SWITCH: Oak wafers with G. H. Leland type of Rotary Solenoid.

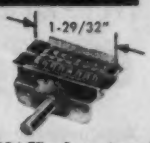
SLIDE

2-POSITION: Shorting type with floating slider.
Series 70



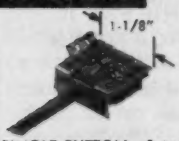
COMPLICATED SWITCHING: 2 to 4 positions; up to 20 poles; very thin.
Series 150

ROTARY SLIDE

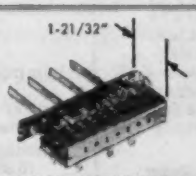


COMPACT—2 to 4 positions; max. switching in min. space.
Series 160

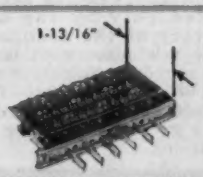
PUSHBUTTON



SINGLE BUTTON—1 to 4 poles; spring return and push-push.
Series 170, 175



SIMPLER CIRCUITS: 3 to 12 buttons; very adaptable unit.
Series 80



COMPLICATED CIRCUITS: 1 to 18 buttons, up to 32 contacts each.
Series 130

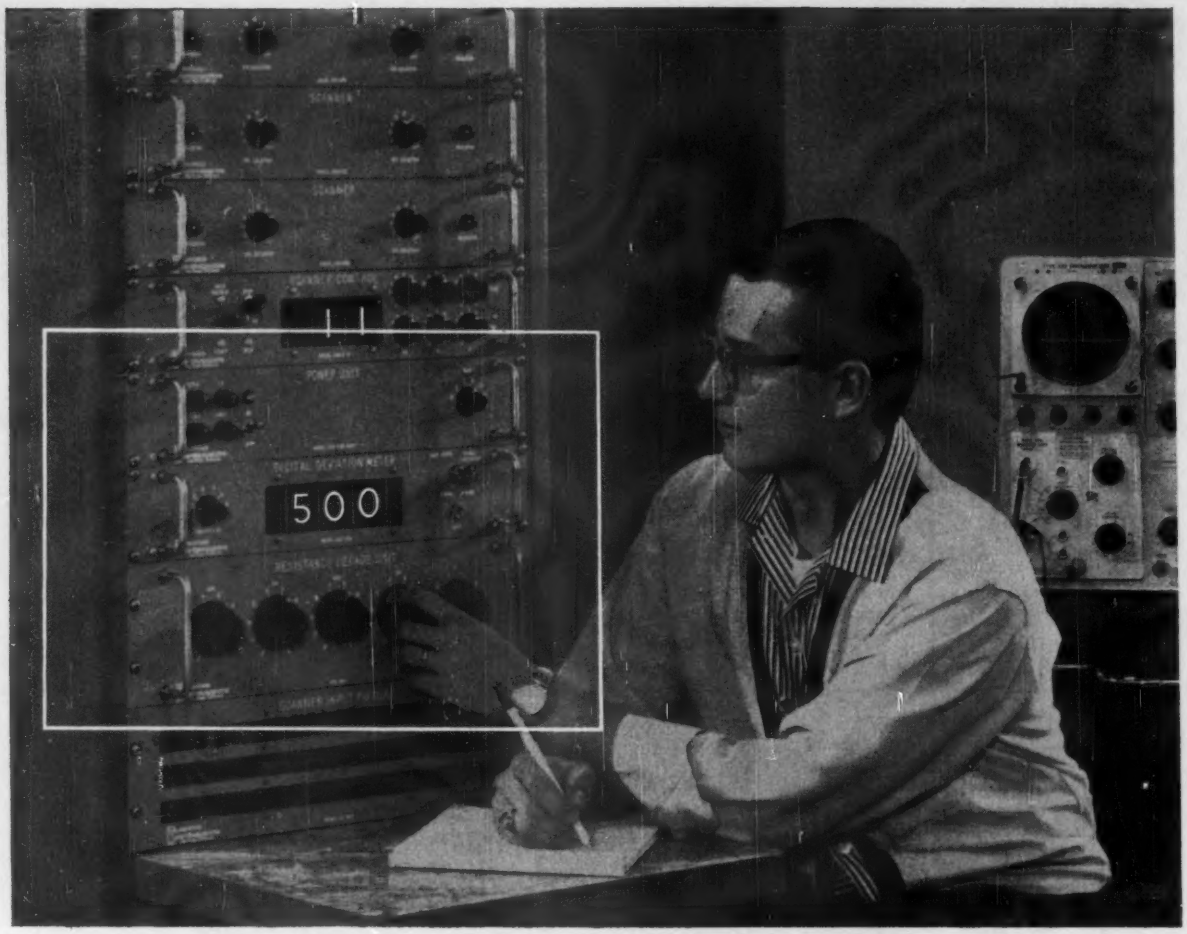
ULTRATHIN: 1 to 12 buttons; up to 14 contacts per button.
Series 131

Quick Solutions for Busy Designers

OAK MFG. CO.

1260 Clybourn Ave., Dept. G, Chicago 10, Illinois
Phone: MOhawk 4-2222

Designing a low-power switch can sometimes turn into a real tussle. Before this happens, call in Oak specialists. From a vast store of past designs and experience they are able, many times, to offer a readymade solution . . . whether it be for a standard unit, something unusual, or a complete package of circuitry. The result is the *exact* switch you need, representing top engineering and optimum economy.



New EI Deviation Ohmmeter...

5 digit accuracy with 3 digits!

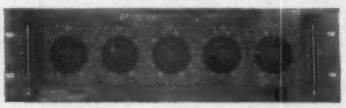
Automatically measures resistance, presents results in percentage of deviation from nominal value!

Testing of resistors can now be done 40% faster and with almost complete freedom from human error. The new EI Model DDM-300 Deviation Ohmmeter measures around any selected nominal value and presents the information in digital form as a direct percentage of this value. Possibility of ambiguous readings, reading the wrong range, or mistakes in calculating deviation from an absolute value, is eliminated.

Speeds testing – Using three digits, instead of five, and elimination of time consuming range changing, reduce the average reading time by 40%. Average balance time is one second.

0.01% accuracy–The instrument reads ±5% of the total resistance to an absolute accuracy of 0.01%. The chosen ±5% range is measured to a full, three-digit accuracy. Essentially, reading accuracy is limited only by the absolute accuracy of the nominal value.

The new instrument is particularly suited for automatic measurement of temperature co-efficients. Contact closures are available for go/no go and tolerance sorting operations.



Values can be referenced to a single resistor of known value or set with the optional precision resistance decade unit (shown above).

If you are testing resistors in quantity, you will want complete information on this extremely versatile instrument. Get in touch with your nearest EI field engineer today.

BRIEF SPECIFICATIONS

Display:
3 digits, over range indication.

Resistance range:
10 ohms to 10 megohms.

Accuracy:
The instrument reads ±5% of the total resistance to an absolute accuracy of 0.01%.

Speed:
1 second, average.

Engineers: Many challenging positions are open. For details contact Mr. Carl Sibelius.

Electro Instruments, Inc.

E I 3540 AERO COURT SAN DIEGO 11, CALIF.

Digital instruments for measuring AC/DC voltages, AC/DC ratios, resistance, capacitance, and frequency • X-Y recorders and accessories • DC amplifiers

INHERENT STABILITY

Assured in a DALOHM 750 or 1000 Trimmer Potentiometer

The ability to perform reliably under extreme conditions of heat and humidity is only one mark of the inherent stability that is standard in Dalohm trimmer potentiometers.

Stored on the shelf for months . . . or placed under continuous load . . . operating in severe environmental, shock, vibration and humidity conditions . . . Dalohm precision trimmer potentiometers retain their stability because it has been "firmly infixed" by Dalohm design and methods of manufacture.

For all applications demanding trimmer potentiometers that meet or surpass MIL specifications, you can depend on Dalohm.

WIRE WOUND • SEALED • HIGH POWER • DALOHM TYPE 750 and 1000 TRIMMER POTENTIOMETERS

Miniature and standard sizes with completely sealed cases. Three terminal configurations provide the solutions for demanding design problems.

	750	1000
Rated at	...2 watts	2.5 watts
Resistance range	.....10 ohms to 30K ohms	10 ohms to 50K ohms
Standard tolerance	...± 5%	± 5%
Size	.....180" x .300" x 1.000"	.180" x .300" x 1.25"
Screw adjustment	..17 ± 2 revolutions	25 ± 2 revolutions
Weight	.....2 grams	2.5 grams

- Completely sealed
- Meets humidity requirements of MIL-STD-202A, Method 106A or MIL-E-5272A, Procedure 1
- End resistance is 3%, maximum
- Nominal resolution is from 0.1% to 1.2%
- Temperature coefficient is 50 PPM/° C.
- Meets load life requirements of MIL-R-19A
- Surpasses applicable paragraphs of MIL-R-12934A

Write for Bulletins R-41A and R-44, with handy cross-reference file cards.

SPECIAL PROBLEMS?

You can depend on DALOHM, too, for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks; collet-fitting knobs; and hysteresis motors. If not, just outline your specific situation.

from **DALOHM**
Better things in smaller packages
DALE PRODUCTS, INC.
1300 28th Ave., Columbus, Nebr.

Veeder-Root READOUT Bulletin

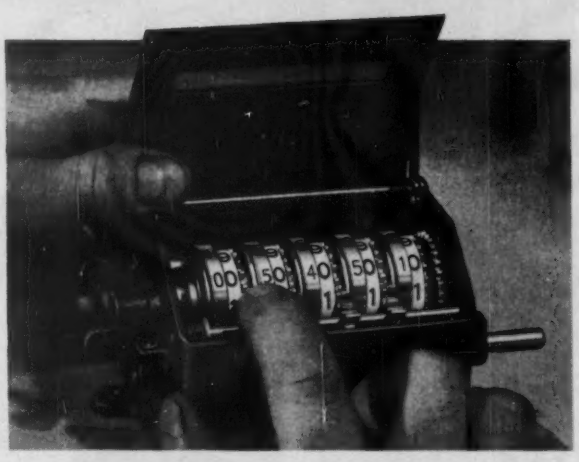
One of a Series

Predetermining Counters provide simplified methods for Automatic Control

Veeder-Root Predetermining Counters now make it possible to design and build automatic control into equipment of all types. They are available for mechanical, electrical and electronic control and offer many features and options to give your equipment extra value and versatility.

Predetermining Mechanical Counters can be applied to rotary, eccentric or stroke type motion, registering or counting whatever units are required — such as revolutions, motions, turns, pieces, lengths, and strokes. The newer electric and electronic Predetermining Counters use a special high speed light source and photo cell for non-contact counting on any machine or process.

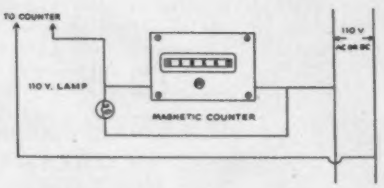
Automatic control is provided by the predetermining counter actuating such devices as: lights, bells, signals and stop motions. They work at speeds up to 8000 counts per minute, can be easily incorporated into machine design and control panels. Application assistance is available from a Veeder-Root Counting Engineer; and specialized designs and modifications can be supplied in most cases. For complete information, call or write your nearest Veeder-Root office.



The High Speed Predetermining Counter is the basic counter in this complete line. It provides automatic control by this simplified method: . . . to set a run of 5451 pieces on the counter: (1) Set all white wheels to zero with one turn of wing-nut; (2) Now, set the metal wheels, one by one. Set first wheel to "5", opposite zero on its "opposite number" white wheel, then set the "4", "5" and "1" and that's all . . . you're ready to throw the switch and start the run.

High Speed, Quick Reset Predetermining Counters for electrical and mechanical control, at speeds to 8000 cpm.

This counter has one set of wheels which are preset to any figure within the capacity of the counter by depressing the reset lever, raising the cover, and turning. The counter subtracts from the preset number to "00000", when a knock-off lever actuates an electrical switch. To reset, just press the reset lever, and counter returns instantly to preset figure. For Mechanical Control, counter actuates a mechanical lever instead of electrical switch. Speeds: 6000 rpm or 8000 counts per minute.



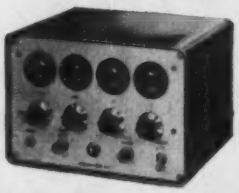
Addition of Magnetic Counter Provides Record of Total Lots.

A Veeder-Root Magnetic Counter connected in series with the alarm or stop motion registers one unit for each of the predetermined lots produced. Provides a simple means to obtain both machine control and production control.

Electric Predetermining Counter Ideal for Batching, Length Measurement and Materials Handling.

This new counter offers automatic reset plus other important features: **1.** Instant automatic reset . . . Control contacts operate and hold for 0.3 seconds . . . or for 2 seconds . . . or indefinitely. **2.** Counter can be modified for automatic sequential predetermining, using two or more preset numbers. **3.** A batch or totalizing counter can be added. This counter is adaptable to material handling applications, slow speed batch counting, length measurement, slitting, and similar applications. Speeds up to 1000 cpm.

High Speed Electronic Predetermining Counters Feature Automatic Reset, 5000 cps.



The No. 1604 features instantaneous recycling. Up to six decade counters, with one, two, or more sets of preset numbers . . . with or without photohead or enclosure. Output relay provides momentary or indefinite holding time. Batch totalizing available. Ideal for all high speed counting, up to 5000 cps, recycle at 1000 cps.

Send for Literature and Technical Data . . . Extensive information and specifications on how to use Veeder-Root Predetermining Counters are yours for the asking. Send today.

Veeder-Root

HARTFORD 2, CONNECTICUT

"The Name that Counts"

New York • Chicago • Los Angeles • San Francisco • Seattle
St. Louis • Greenville, S. C. • Altoona, Pa. • Montreal
Offices and Agents in other principal cities

NOW TEST TRANSISTOR BETA IN THE CIRCUIT WITHOUT POWER ON!

New Sierra 219A Transistor Tester reads Beta directly in the circuit; also measures I_{co} and Beta out of circuit. Simple operation, completely portable. Battery powered; easily used anywhere.

DON'T TAKE IT OUT!

Consider the real advantages of testing transistors in the circuit. Downtime, and damage to transistors, is greatly reduced. Complete assemblies are quickly checked out. Quality control "ounce of prevention" is simplified during manufacture.

Beta is read simply and directly in or out of the circuit; a basic function of the Sierra 219A is to electrically isolate the transistor under test permitting accurate in-circuit tests. I_{CO} is measured on a straightforward dc basis; collector potentials of 3, 6, or 12 vdc may be selected.

For complete information and demonstration, telephone your Sierra representative now.

SPECIFICATIONS

Test Ranges:	Beta, 10 to 100, I_{co}, 0 to 50 μamp
Accuracy:	In-circuit ± 20% for external loadings above 500 ohms Out-of-circuit ± 10%
Power:	Mercury or zinc-carbon battery; 1,000 hrs. average service life; meter indicates battery output
Temperature Range:	32° to 122°F for specified accuracy
Dimensions:	9" high x 7⅛" wide x 6½" deep; weight 16 pounds
Accessories:	Test leads supplied
Price:	$250.00 f.o.b. factory Delivery from stock

Data subject to change without notice

Sierra

SIERRA ELECTRONIC CORPORATION

A Division of Philco Corporation

6251A BOHANNON DRIVE • DAvenport 6-2060 • MENLO PARK, CALIFORNIA, U. S. A.

Sales representatives in all principal areas

Canada: Atlas Instrument Corporation, Ltd., Montreal, Ottawa, Toronto, Vancouver, Winnipeg

Export: Frazar & Hansen, Ltd., San Francisco, Los Angeles

VERSATILE

Multi-channel—telegraph A1 or telephone A3

STABLE

High stability (.003%) under normal operating conditions

RUGGED

Components conservatively rated. Completely tropicalized

FROM GROUND TO AIR OR POINT TO POINT

Here's the ideal general-purpose high frequency transmitter! Model 446, suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Coaxial fittings to accept frequency shift signals.

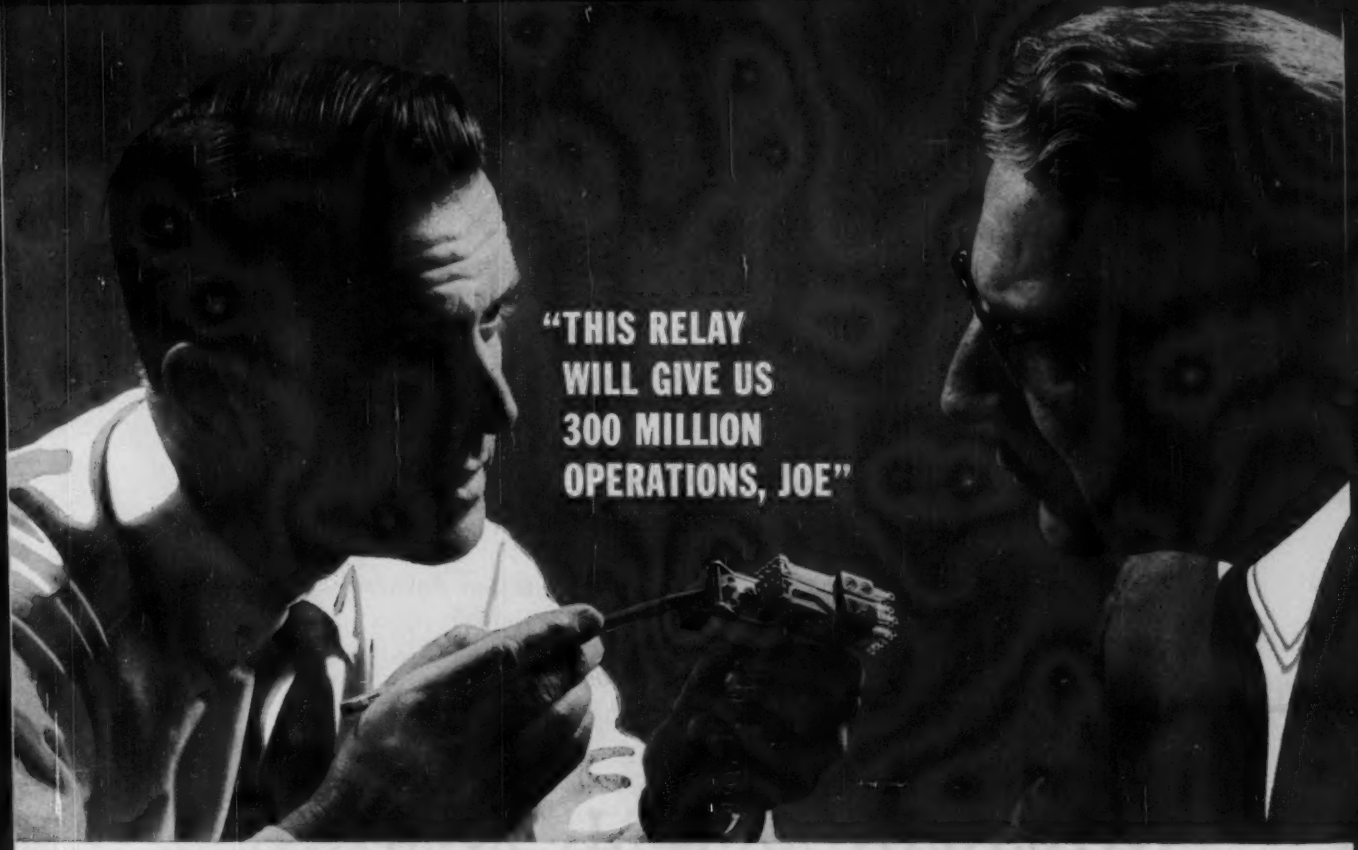
This transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3. Stability .003%. Nominal 220 volt, 50/60 cycle supply. Conservatively rated, sturdily constructed. Complete technical data on request.

Now! Complete-package, 192 channel, H.F., 75 lb. airborne communications equipment by Aer-O-Com! Write us today for details!

AER-O-COM

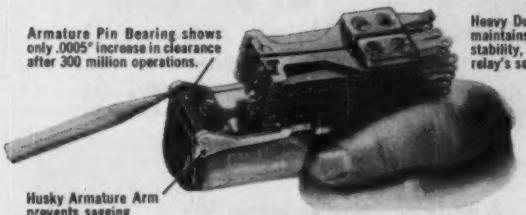
A-131

3090 S. W. 37th AVENUE MIAMI 33, FLORIDA



HERE'S WHY P&B TELEPHONE TYPE RELAYS GIVE YOU

reliable performance over long life


Armature Pin Bearing shows only .0005" increase in clearance after 300 million operations.
Heavy Duty Frame maintains dimensional stability, adds to relay's sensitivity.
Husky Armature Arm prevents sagging or bending.

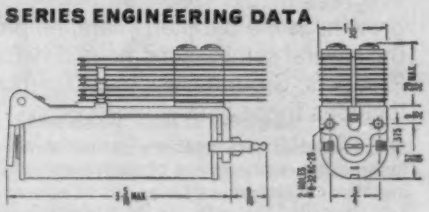
BS SERIES TELEPHONE TYPE

Measure the thickness of the BS series armature arm. You will find the cross section area is greater than ordinary relays of this type. Here is the kind of quality that spells dependability.

Observe that the stainless steel hinge pin runs the full width (not just half) of the armature, providing optimum bearing surface. This pin, operating in a stainless steel sleeve, shows only minimal wear during nearly a *third of a billion operations.*

Best of all, P&B quality costs no more. A whole new plant is being devoted to the production of high performance telephone type relays. Your nearest P&B sales engineer will be happy to discuss your relay problems. Call him today.

BS SERIES ENGINEERING DATA



GENERAL:
- **Breakdown Voltage:** 1000 volts rms 60 cy. min. between all elements.
- **Ambient Temperature:** −55° to +85° C. +125° C available on special order.
- **Weight:** 9 to 16 ozs.
- **Terminals:** Pierced solder lugs; Coil: One #16 AWG wire Contacts: Two #18 AWG wires
- **Enclosures:** Dust covered or sealed

CONTACTS:
- **Arrangements:** DC—up to 28 springs AC—up to 24 springs
- **Material:** ¼" dia. twin palladium. Up to ¼" dia. single silver. Other materials on special order.
- **Load:** 4 amps at 115 volts, 60 cycle resistive
- **Pressure:** 15 grams minimum

COILS:
- **Resistance:** 100,000 ohms maximum
- **Current:** 10 amps maximum
- **Power:** DC—50 Milliwatts per movable arm. Greater sensitivity on special order. AC—17.9 volt-amps.
- **Duty:** Continuous
- **Treatment:** Centrifugal impregnation
- **Voltages:** DC—up to 300 volts with series resistor. AC—up to 250 volts, 60 cy.

MOUNTING: Two #8-32 tapped holes ¾" o.c. Other mountings on special order.

GS SERIES—Excellent sensitivity: 50 mw per movable arm minimum (DC). For applications requiring many switching elements in small space.

LS SERIES—Medium coil relay with short springs and light weight armature for fast action, reliability and long life.

TS SERIES—Short coil relay is available in AC and DC versions. Long life construction. Can be supplied (DC) with up to 20 springs (10 per stack).

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

CIRCLE 67 ON READER SERVICE CARD

We promise that you will hear from us within one week!

Important openings for senior E.E.'s and Physicists to assume responsibility for development of

new infrared search systems

Progress of the Hughes Infrared and Guidance Department reflects Hughes overall growth. In the past ten years, employment has risen from under 2,000 to over 34,000 in the several semi-autonomous divisions of Systems Development, Research, Commercial Products, Ground Systems, Communications and Manufacturing. The infrared activity includes these typical projects:

These activities have created a number of new openings for graduate engineers and physicists with analytical and inventive abilities.
You are invited to investigate these openings if you have several years of applicable experience in infrared optics or electronics, and can assume responsibility for systems analysis and preliminary design.
The importance of infrared development at Hughes is shown in substantial development contracts and in the fact that Hughes is investing its own funds in further exploration.

1. **Air-To-Air Missiles**
2. **AICBM**
3. **Air-To-Air Detection Search Sets**
4. **Satellite Detection & Identification**
5. **Infrared Range Measurement**
6. **Detection Cryogenics**
7. **Detector Application Physics**
8. **Optical Systems Design**

We invite your earliest inquiry. Wire collect, or airmail resume directly to:

Mr. William Craven, *Manager, Infrared*
Hughes Systems Development Laboratories
Culver City, California

HUGHES

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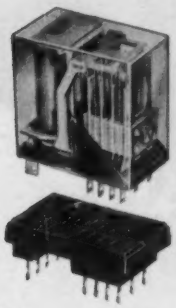
Write for reprints of these important technical papers, written by Hughes staff members...
Infrared Search-Systems Range Performance: R. H. Genoud /Missiles Seekers and Homers: W. A. Craven, et al.
Servomechanisms Design Considerations for Infrared Tracking Systems: J. E. Jacobs /Simulation of Infrared Systems: H. P. Meissinger

ALLIED CONTROL'S

NEW LINE OF

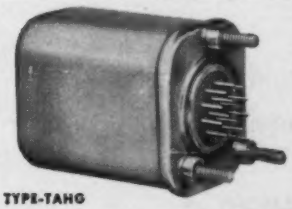
Sub-Miniature Telephone Type Relays

Now being manufactured entirely in the U.S.A., not only in its original West German design previously sold in this country by Allied Control Company, Inc. under an agreement with Siemens & Halske Company A.G. Germany but with variations to meet American requirements as well.



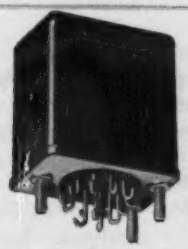
TYPE-T-154

H- 1 3/16 ● W- 47/64 ● L- 1 11/64



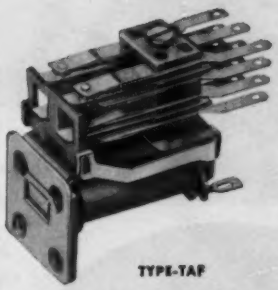
TYPE-TAHG

H- 2 3/16 ● W- 1 7/16 ● L- 1 5/8



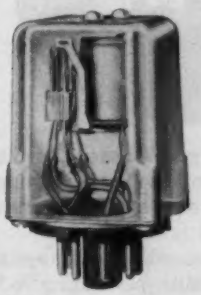
TYPE-TAH

H- 1 19/32 ● W- 61/64 ● L- 1 11/32



TYPE-TAF

H- 1 17/64 ● W- 41/64 ● L- 1 5/16



TYPE-TADO

H- 2 ● W- 1 13/32 ● L- 1 13/32

PERFORMANCE CHARACTERISTICS

Contact Arrangement
Up to 12 springs maximum form A, B or C

Contact Rating
2 amperes resistive or 1 ampere inductive at 29 volts d-c or 115 volts a-c
Low level or 5 ampere contacts available on request

Standard Coil Voltages
Suitable coil resistances can be supplied for operation at any voltage within the range of 0.5 to 130 volts d-c

Coil Power
Nominal: 700 milliwatts
Minimum Operate Power: 60 to 150 milliwatts depending on application, contact arrangement and coil resistance.

Timing at Nominal Voltage
Operate time: 7.5 milliseconds maximum
Release time: 3.5 milliseconds maximum

Vibration
10-55 cps at .062 inch double amplitude
55-500 cps at a constant 10g

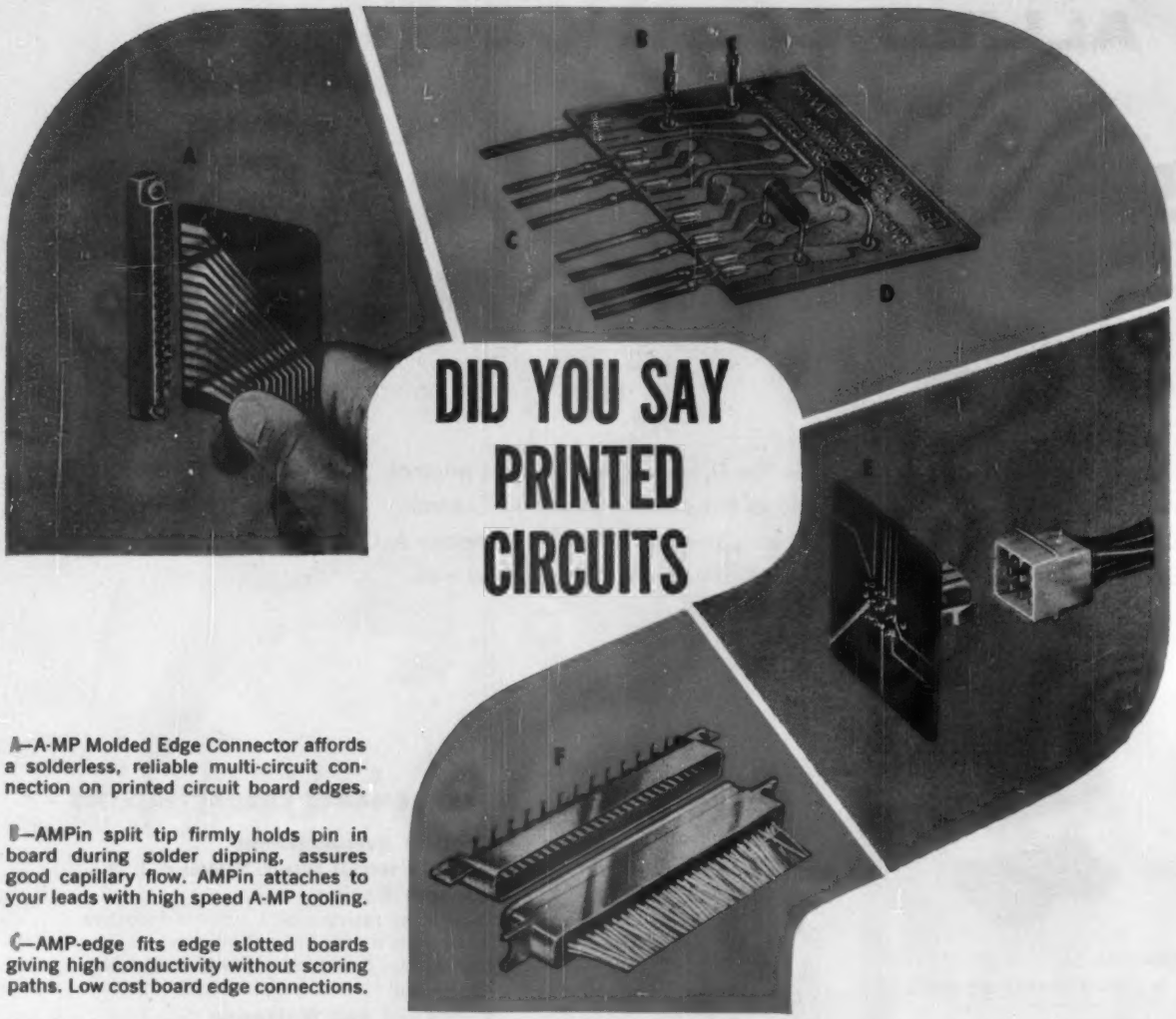
Shock: 25g operational

Enclosure
Open, dust cover or hermetically sealed

Weight
Open type 1.0 ounce maximum
Sealed type 2.0 ounces maximum

ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, NEW YORK



DID YOU SAY PRINTED CIRCUITS

A—A-MP Molded Edge Connector affords a solderless, reliable multi-circuit connection on printed circuit board edges.

B—AMPin split tip firmly holds pin in board during solder dipping, assures good capillary flow. AMPin attaches to your leads with high speed A-MP tooling.

C—AMP-edge fits edge slotted boards giving high conductivity without scoring paths. Low cost board edge connections.

D—A-MP Component Tips crimp to component leads for firm mounting during solder dip. Permit stacking of units, protect semi-conductor leads from heat.

E—AMP-lok—economical multiple quick connect/disconnect of harness to board.

F—A-MP Printed Circuit Connector, for gruelling aircraft environments, is sealed against moisture and arcing, attaches with right angle pins to circuit board edge. Dual leads for each contact.

A·MP

No matter how you approach printed circuit problems—with single or multiple connector units, with board-edge or face attachments, with or without solder dipping, with or without eyeletting—AMP has just the product you'll need for low-cost top reliability.

Production and assembly speeds are miles ahead of most other techniques. Versatility is unbeatable, permitting A-MP products to be used on different applications and in combination with each other.

For complete information on electrical characteristics, application methods and other specifications, send for our new Printed Circuit Applications Catalog.

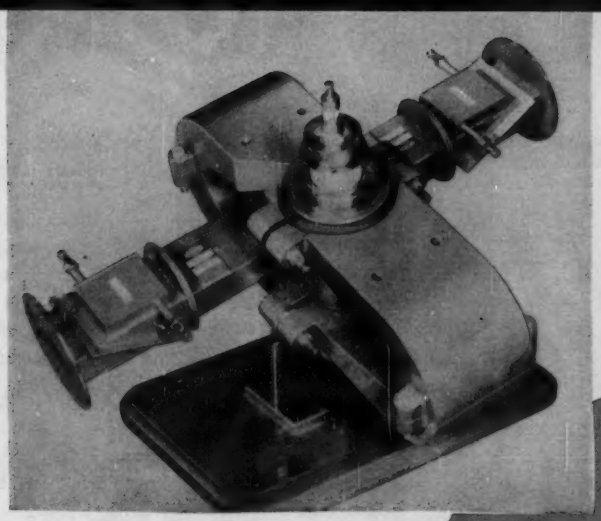
AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan

electronics

JANUARY 15, 1960



This QK622 functions same way as the high-heat-dissipation experimental tube

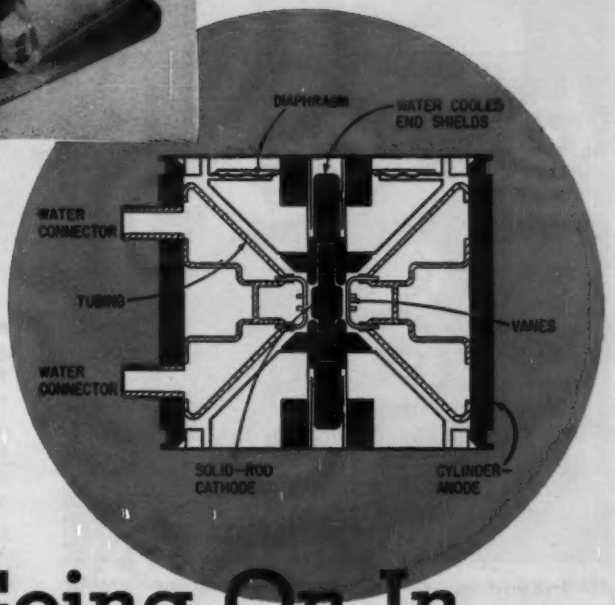


FIG. 1—Cross section of experimental tube shows tubing which composes the slow-wave structure

What's Going On In Advanced Research

New high-power microwave tube is among developments revealed at Northeast Electronics Research and Engineering Meeting

By **THOMAS MAGUIRE**, New England Editor, and **SY VOGEL**, Associate Editor

THEME OF THE 1959 Northeast Electronics Research and Engineering Meeting (NEREM) was advanced research-and-development. Among the technical papers were reports on: an impending breakthrough in microwave-tube power, a new crossed-field microwave amplifier, a fresh approach to the problem of stabilizing maser gain, a new semiconductor switch, developments in electron-beam technology, and thermoelectric cooling of transistors.

MICROWAVE SUPER POWER—A new concept in microwave-tube design foreshadows a breakthrough in economic generation of large quantities of microwave power in the S-band region.[1] Pulsed tubes may have an average r-f power output of 200 kw, and eventually, 400 kw. The new design makes possible a 10-fold increase in the heat removed from an anode, thus permitting a 10-fold increase in tube input and output power levels without a large increase in physical size or cost. This increase in heat-dissipation density, combined with high efficiency, produces 10-kw output for each sq cm of anode area; 20 kw/sq cm may be possible, eventually.

These large anode-dissipation densities have been experimentally confirmed in an X-band Amplitron, a cross section of which is shown in Fig. 1. The slow wave structure is constructed of very small tubing having an inside diameter of 0.018 in., through which water is circulated. Wall thickness is only 0.006 in., so the heat generated by electron bombardment of

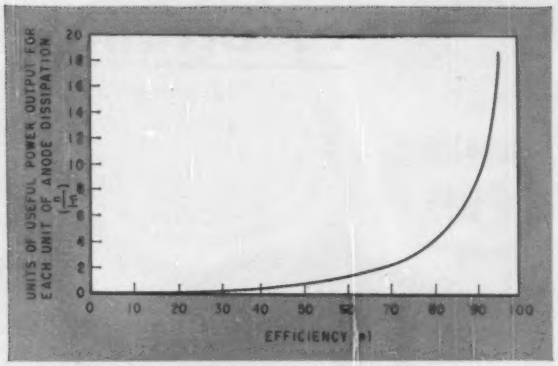


FIG. 2—Output power is function of anode efficiency when anode dissipation is the limiting factor

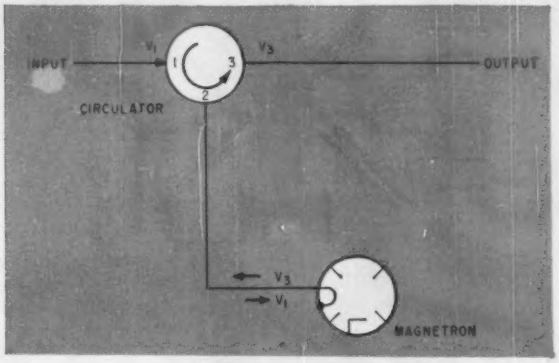


FIG. 3—A circulator and a modified magnetron comprise this amplifier

the slow wave structure is easily conducted to the water coolant. Water flow through the tubing is in parallel flow. Due to the short distances involved, a difference of only 100 psi between input and output water connectors causes water to flow through the tubing with high velocity. In this small Amplitron, which has a total projected anode area of only slightly more than one cm sq, it has been possible to dissipate 8 kw in the anode under conditions of close to 50 percent operating efficiency. Projected anode area is the product of vane diam, the length over which the vanes collect anode current and the number of vanes.

Higher heat-dissipation densities than those already achieved could result by using a higher water pressure, with a resultant increase in flow velocity of the coolant. A value of 3 kw/sq cm is a conservative figure for future designs.

In a device limited by anode dissipation, the combined effect of large dissipation density and higher efficiency produces a sharp increase in useful r-f output power, as shown in Fig. 2. Combining a dissipation density of 3 kw/sq cm with 80 percent efficiency, 12 kw of useful r-f power may be obtained for each sq cm of anode area. Thus, in a modified S-band Amplitron with an anode area of 22 sq cm a useful r-f output of 264-kw-average power could be predicted.

Within a few years there will be tubes which cost \$10 to \$20/kw of output power, assuming a reasonable rate of production. No longer will a microwave tube represent the limiting cost of a communications or primary-power system.

CROSSED-FIELD AMPLIFIER—This is a microwave amplifier which uses a magnetron as a negative-resistance element in much the same way that a maser uses an active material.[2] Still in the development stage, the Circlotron is a one-port, non-linear, high-power amplifier which retains the efficiency and simplicity of the magnetron. Small time delay and small phase shift (between +45 to −45 deg over the ½-power bandwidth) are characteristic of the device, so it may find special application in the transmitter portion of phased-array systems. Important uses are projected for it in regions of the microwave spectrum where high-power amplifiers are not available, but magnetron oscillators are at hand. Also, some measurements may increase knowledge of magnetron space-charge characteristics.

As shown in Fig. 3, a circulator separates input and output signals and isolates the negative resistance from variations in the load and source impedances. Because the cathode is part of the resonant circuit, the r-f fields cause electrons to back-bombard the cathode, thus supplying the required cathode current by secondary-electron emission. This type of r-f starting requires only a sufficiently large signal to trigger the process. Elimination of the heater promises increased operating life of the cathode.

Experimental tubes operating in X-band (a representative frequency is 9,100 mc) have given gains greater than 10 db over a 10-percent bandwidth, with efficiencies between 30 and 60 percent at a 7-kw-peak output level.

MASER GAIN STABILIZER—Figure 4 shows the L-band maser system which is part of Harvard Observatory's radiometer.[3] The radiometer is used principally to study 21-cm radiation from external galaxies. A total input-noise temperature of 85 K has been realized, including contributions from antenna spillover, input losses, and the receiver stages that follow the maser. The gain-bandwidth product of the maser (Fig. 5) is 20 mc at a bath temperature of 4.2 K.

To minimize gain fluctuation, a stable modulated-noise signal is injected into the input-signal line and used as a reference signal to control the maser gain. A discharge lamp (*noise tube*) generates this noise, which is square-wave modulated at 300 cps. At the second-detector output, the noise step is picked out by a synchronous detector. The noise step is then compared with a fixed reference voltage at *ampl* 1.

After amplification, the error signal goes to a d-c controlled attenuator (Gyraline) which varies maser pump power, thus controlling maser gain.

Gyraline operation is restricted to the initial 4 or 5 db of its attenuation range so that the maser is never far from saturation and very little gain-bandwidth product is sacrificed. The corresponding control range of maser gain is about 2 db; this is adequate to take care of gain drifts over a long period.

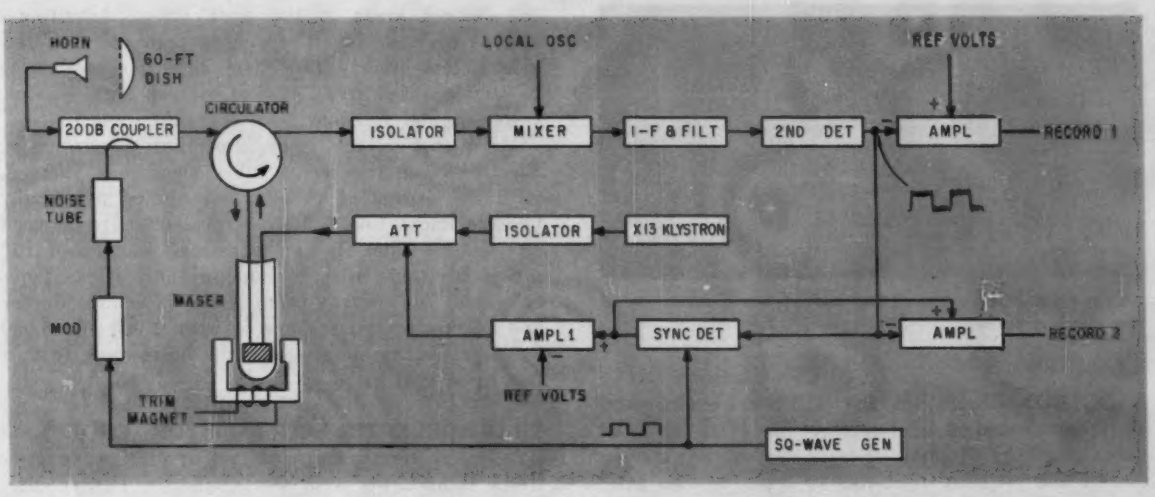


FIG. 4—Radiometer system; stabilization circuit controls maser gain. Klystron supplies pump power

At intervals during observation, gain is set back manually to the middle of the automatic gain stabilization (ags) range.

The ags loop gain of about 30 reduces gain drifts, which might otherwise amount to several percent during an observation, to the order of 0.1 percent. Such small drifts are not troublesome if they are linear.

Success of the ags scheme depends on the gain of stages following the maser remaining constant. If the gain of these stages should vary while at the same time the overall gain is held constant, the contribution of these stages to the input-noise temperature will change. Such a change would be equivalent to a spurious input signal. Fortunately, it is possible to maintain gain stability in the post-maser stages to better than one part in a thousand by careful regulation of supply voltages and ambient temperatures.

It is possible to record output in two ways. The total second-detector output is differenced against a battery in the *record* 1 channel. The mean second-detector output is differenced against the amplitude of the noise step in the *record* 2 channel. The second channel has the advantage that residual gain fluctuations affect both its inputs in the same ratio and should therefore not appear in its output. However, fluctuations are enhanced in this channel since two noise voltages are compared.

The system has employed a 20-db coupler and a 100-K noise-step tube to record with minimum added noise in the first channel. It is possible that a coupling factor between 10 and 20 db would be better.

CONTROLLED-RECTIFIER SWITCH — A new semiconductor component, the Transwitch[1], is designed for computer applications. It can be turned off by a relatively small negative pulse, compared to the negative pulse required to turn off a conventional silicon controlled rectifier. Physical configuration is shown in Fig. 6A; Fig. 6B shows the equivalent transistor circuit.

The component operates at relatively low currents (50 ma) and low voltages (30 v). Beta decreases with increasing load current; thus turn-off current must be increased as load current is increased. Compared to the silicon controlled rectifier, whose approximate turn-off beta is 2, turn-off beta of the Transwitch is between 5 and 10. Turn-on time is inversely proportional to input-pulse height and width. Pulse height must be sufficiently positive or negative to turn the switch on or off. The higher the temperature, the higher is the required switch-off current.

Although the switch can be turned off by any pulse below a minimum level, the turn-off transient will not be clean unless the turn-off pulse is appreciably more negative than this level.

Counters have successfully performed with these switches up to 20 kc. Switching at 1 μsec should eventually be feasible.

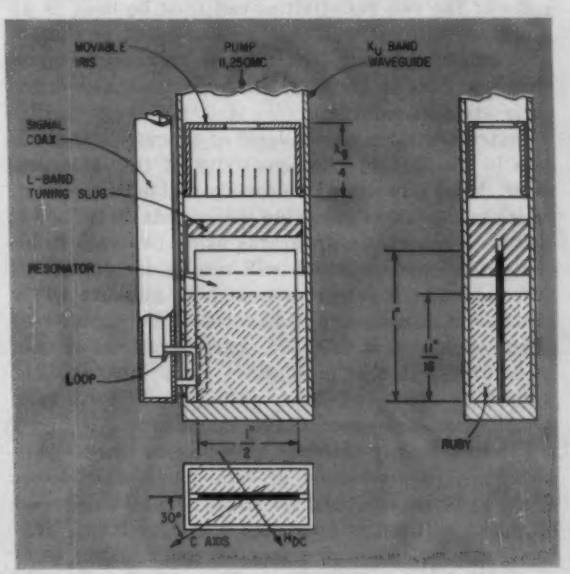


FIG. 5—Teflon tuning slug slides over maser resonator; coupling loop nestles into resonator slot. See front cover

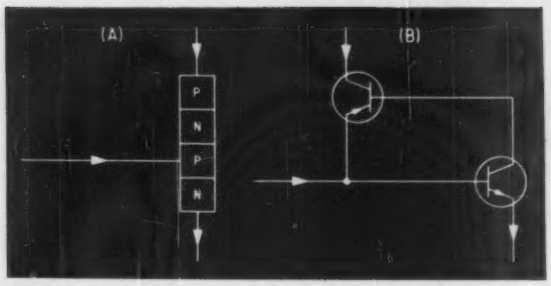


FIG. 6—Physical representation (A) and equivalent circuit (B) of new switching device

ELECTRON BEAM TECHNIQUES — Development work has started on an electron-beam device for accurate machining of small holes in evaporation masks, one of the pressing problems in micro-module programs.[5] The holes must be accurate in dimension, positioned accurately, and have good registration between the masks in each set. The new device works on the same pulsed-energy principle as used in Zeiss electron-beam techniques, but it drills out all holes simultaneously without motion of the work piece. The setup is shown in Fig. 7. A stencil mask of a convenient size is illuminated by a collimated beam of electrons. The large stencil is imaged at a good-size reduction on the work piece and all the holes are drilled at once by pulsing the illuminating beam.

In another aspect of metallurgy for electronics, space requirements have created vast need for refractory metals with improved physical and electrical characteristics—and most of the improvements have come about through ultra purification. A basic limitation on ultra-purification research is the extreme difficulty of measuring low-level impurities. One technique is to measure the resistivity of the material at room temperature and then in liquid helium. The ratio of the two resistivities can then be used as an index of purification. This measurement is reasonably sensitive, but it does not give an absolute quantity, nor does it identify the impurities and define their state chemically.

Instrumentation at the level of primary-standards labs is required by the sensitivity of this measurement. Many labs use a Rubicon six-dial potentiometer, which is capable of resolving increments of 10^{-6} v d-c. Bell Labs reports an apparatus using two such Rubicon potentiometers which will resolve increments of 10^{-9} v d-c and is sensitive enough to measure 10^{-6} v absolute to an accuracy of 10 percent. Estimated cost of the apparatus is $200,000. Large problems remain to be solved in this area, since many labs working with Hall effect and Zener voltages will soon have to make measurements of this magnitude.

Electron-beam techniques have become increasingly important in production of semi-conductor devices. Electron beams are used for three general categories of work: cutting, joining, and film deposition.[6] Material can be deposited either by the masking technique or by using electrostatic or electromagnetic fields to focus the ionized vapor and direct it onto the desired areas of the work piece. Advantages include high efficiency of energy transfer with few side effects, ability to deliver high power density to very localized areas, ease of control, high dynamic response, and freedom from contamination.

High cost is the most important disadvantage. Electron-beam processing takes place in a vacuum, with the degree of vacuum determined principally by experimentation. Generally, pressures are between 10^{-5} and 10^{-6} mm Hg; an ultra-high vacuum of 10^{-9} mm is advisable in semiconductor fabrication. Typical values for electron-beam power in semiconductor and micro-circuit work are between 1,000 and 5,000 w. Accelerating voltages for the beam vary from a few to several kv.

THERMOELECTRIC TRANSISTOR COOLER — Wide-range temperature control of dissipative electronic components with semi-conductor Peltier cooling is within the existing state of the art.[7] Peltier junctions perform heat pumping at the dissipation levels met in typical electronic circuits. Use of the technique to extend a transistor's dissipation limit is a practical illustration.

A transistor cooler assembly is shown in Fig. 8. Active part of the unit consists of two bismuth-telluride thermocouples comprising two *n*-type and two *p*-type legs. Thermocouples are connected electrically in series and thermally in parallel. The cold junctions are soldered to the platform supporting the transistor. Heat-sink ends of the thermocouples are soldered to nickel-plated copper blocks, and these

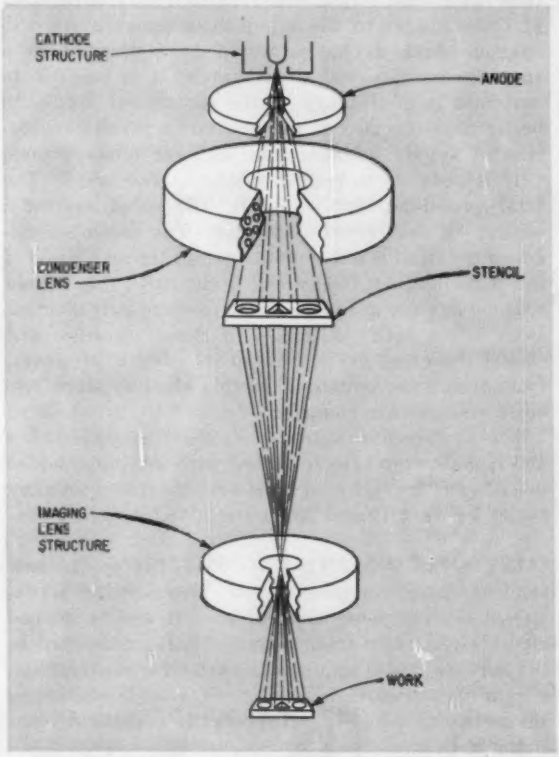


FIG. 7—Electron beam drills holes simultaneously

blocks are mounted on a nickel-plated copper platform. A thin sheet of mica electrically isolates the thermoelectric structure from the outer case. A 15-w transistor with a 1-deg-C/w thermal resistance in its case is mounted on the cooled platform. Ten glass-to-metal seals are soldered into the base of the assembly to provide lead-throughs for the transistor, the thermocouples, and a thermistor.

Performance of the cooler was tested at ambients of 5 C and 102 C. Device performance was practically constant over this range, not because of the constancy of semiconductor properties, but because the deteriorating effect of heat was prevented. In a typical test, with the collector dissipating 4 w, a power input of 7 w was required to cool the collector to 80 C.

The geometry of the cooling device determines the heat-pumping capabilities. The requirement of short thermoelements for large heat-pumping capability is compatible with the requirement of fast transient response for good control characteristics. Other materials under development, such as solid solutions of Bi_2Te_3 with Bi_2Se_3 or Sb_2Te_3 with Sb_2Se_3, look promising.

OPTICAL-ELECTRONIC SYSTEMS — These systems may be used in such jobs as communication, navigation, and acquisition and tracking.[8] Optical-electronic systems may be active or passive. The general type of system to be analyzed below is the active, which contains a transmitter of optical energy.

The basic system contains a modulated light source which transmits energy through a medium such as the atmosphere to a detection system. In the transmitter, the modulator determines the frequency spectrum of the light-signal modulation. Thus the modulated signal is described by the center frequency f_c and the bandwidth Δf.

The spectral power of the transmitted beam is $P_\lambda = \alpha\gamma W_\lambda$ where W is the spectral radiant emittance of the source in w/cm — micron, γ is the light-gathering ratio of the transmitter optics and α is the light-source area.

The spectral irradiance of the beam arriving at the input of the detection system is

$$H_\lambda = P_\lambda \Gamma_m(\lambda)/\theta R^2$$

where $\Gamma_m(\lambda)$ is the transmission of the medium at wavelength λ, θ is the solid angle of the beam, and R is the range.

Passing through the detector system, the irradiance is attenuated so that the signal power reaching the detector within the spectral interval $d\lambda$ is $dP = H_\lambda A\Gamma(\lambda)d\lambda$ where A is the effective detector-aperture area and $\Gamma(\lambda)$ is the transmission of the detector-system optics.

The quantum efficiency $q(\lambda)$ of the detector is the ratio of the number of electrons generated by the detector to the number of photons striking it. Using the energy relation $E = hc/\lambda$, the number of electrons generated per second is

$$n = (A/hc)\int_0^\infty \lambda H_\lambda \Gamma(\lambda) q(\lambda) \partial\lambda$$

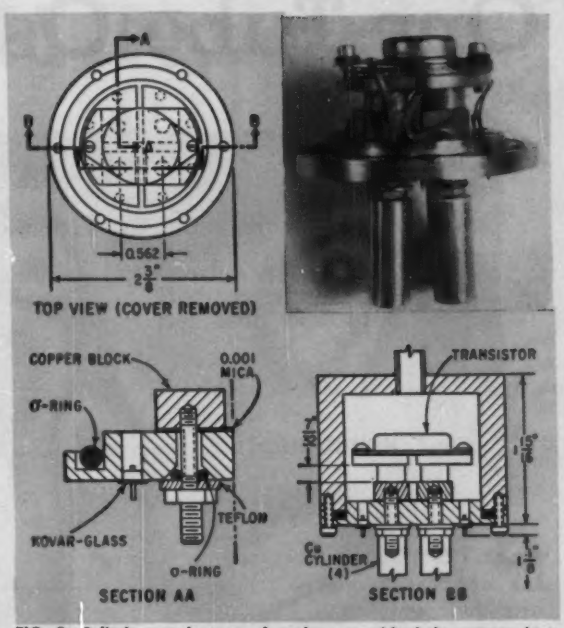


FIG. 8—Cylinders at bottom of cooler assembly help remove heat from heat sink

Thus the input current to the detector amplifier is

$$i_s = en = A\int_0^\infty s(\lambda)H_\lambda\Gamma(\lambda)d\lambda$$

where e is the electron charge and $s(\lambda) = (\lambda_c/hc)q(\lambda)$

Detector-amplifier center frequency and bandwidth should match the modulation characteristic of the light source. Assuming a constant gain, G, the output signal is

$$S = \frac{\alpha\lambda AG}{\theta R^2}\int_0^\infty W_\lambda \Gamma_m(\lambda)\Gamma(\lambda)s(\lambda)d\lambda$$

Radiation noise N_λ is usually the dominant noise component. Where Ω is the angle of view of the detector-system optics, the detector noise current is

$$i_b = A\Omega\int_0^\infty N_\lambda \Gamma(\lambda)s(\lambda)d\lambda$$

Thus the power S/N ratio of the system is

$$(S/N)^2 = (A/2\,\Omega\Delta f)\,(\alpha^2\lambda^2/\theta^2R^2)I(\lambda)$$

where

$$I(\lambda) = (\int_0^\infty W_\lambda \Gamma_m \Gamma s d\lambda)^2 / \int_0^\infty N_\lambda \Gamma s d\lambda$$

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(6) John C. Simons Jr., National Research Corp., Cambridge, Mass., Electron Beams.

(7) P. E. Gray, R. E. Nelson, J. Blair, MIT, Cambridge, Mass., Thermoelectric Temperature Control of Electronic Components.

(8) Edwin Langberg, Elcon Laboratory, Inc., Cambridge, Mass., Design Features of Active Optical-Electronic Systems.

One-Tube Oscillator Mixers

Balanced bridges and semiconductor diodes limit frequency pulling and radiation into the antenna. Frame-grid pentode promises considerable gain improvements. Advantages of new circuit show up in comparison of conventional and modified tuners

By **E. H. HUGENHOLTZ***, Consultant to Amperex Electronics Co., Hicksville, N. Y.

EARLY OSCILLATOR MIXER circuits were based on single tube circuits that combined the functions of oscillator, mixer, and i-f amplifier. Having no buffer between the oscillator section and the r-f stage, these circuits were prone to frequency pulling and radiation into the antenna. Although the drawbacks have been overcome by using circuits with double triodes and triode pentodes, such circuits are complex.

This article describes two groups of circuits that are relatively simple, and whose improved performance offers a promising future. The first group uses a single tube as in the original autodyne circuit, but with the addition of tuned circuits to cancel unwanted coupling. The second group is similar to the first, but uses semiconductor diodes for mixing. Departing from convention, a frame-grid pentode is used in one of the second group of circuits, and its considerable gain promises smaller and more economical i-f amplifiers.

Circuit Operation

Figure 1 shows the basic circuit of the first group of oscillator mixers in a version suitable for tv tuners. Tube V_2 is the oscillator mixer, while V_1 is a conventional r-f amplifier. Coils L_1 and L_2 are the primary and secondary r-f coils; L_3 is the oscillator coil, and the i-f output circuit is formed by L_5 and L_6.

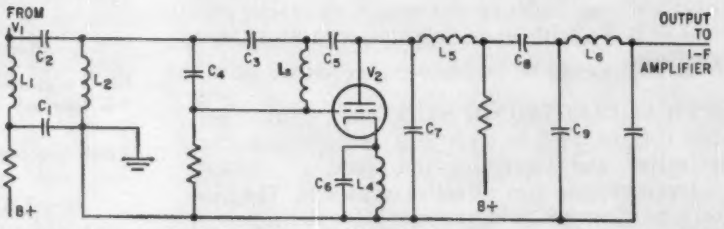


FIG. 1—Single-tube oscillator mixer uses balanced bridges to cancel harmful coupling and feedback

Oscillator coil L_3 is connected between the grid and plate of the oscillator mixer, V_2, through series capacitor C_5. First i-f coil L_5 is a choke for the oscillator signal, which is returned to ground through capacitor C_7.

Coil L_2 is shunted by capacitors C_3 and C_4. The values of C_3 and C_4 are chosen so that their junction is a null, or at least a minimum, for the oscillator signal. The second r-f coil L_2, is connected to this junction and so a minimum signal is fed into it from the oscillator. Thus with a minimum oscillator signal developed across L_2, the radiation into the antenna is reduced.

The bridge diagram of Fig. 2 illustrates the cancellation of the coupling between oscillator circuit L_3 and r-f circuit L_2. No component of the oscillator signal across L_3 will appear across L_2 as long as the relationship $C_3/C_4 = C_5/C_{gk} = C_7/C_6$ exists.

The bridge diagram of Fig. 3 shows the cancellation of i-f coupling between the plate and grid of V_2, which is necessary to prevent undesirable feedback effects. Figure 3 shows that no i-f feedback can cause a signal between cathode and grid if the branch-impedance relationship $Z_1/Z_2 = Z_3/Z_4$ is obtained. The oscillator inductance is not shown in this diagram since its effect at intermediate-frequency is negligible; it would otherwise appear in branch Z_1. The branch Z_2

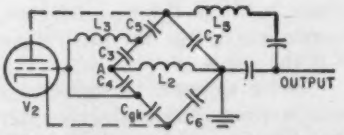


FIG. 2—Bridge prevents oscillator signal from being developed across r-f coil L_2

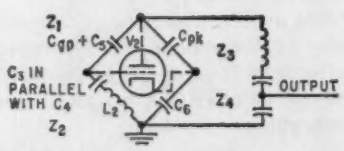


FIG. 3—Bridge prevents i-f signal feedback in V_2

* Now with Rogers Electronic Tubes And Components, Toronto, Canada

For Tv and F-M Tuners

Measuring r-f output of modified turret-type tuner

does contain the r-f coil L_2, however, since the inductance of this coil increases with frequency, thus preventing its omission.

To achieve stability, the bridge is balanced at the lowest frequency at which it will be used. If this were not done, the increase in inductance of L_2 at lower frequencies could result in positive feedback capable of causing unwanted (parasitic) oscillations. This means that operation on the higher channel frequencies brings about some negative feedback and consequent loss of gain. Despite this effect, an experimental tuner of this type showed gain figures comparable to those for a conventional tuner.

Although the circuits described are simple in concept, they suffer in efficiency by having to perform the combined functions of oscillator, mixer and i-f amplifier. Another problem (in tv tuners) is the necessity of maintaining the balance over all channels. This can be accomplished without too much difficulty in turret-type tuners, but for incremental, or switch-type tuners, the balancing presents serious problems.

Furthermore, the capacitive division between C_3 and C_4 causes some loss of gain, while, as in the earlier autodyne circuits, this circuit is susceptible to overloading. Nevertheless, as these unfavorable conditions seldom occur in their extreme form, these circuits still present a simple solution for some applications.

Mixing by Semiconductor Diodes

The second group of circuits was developed to overcome the disadvantages of the circuits based on a single tube, and uses a semiconductor diode for mixing. Thus the functions of oscillator, mixer and i-f amplifier are separated to some extent, permitting greater freedom of design.

Oscillation can be sustained by either plate-to-grid or cathode-to-grid feedback. As plate-to-grid feedback would cause feedback of

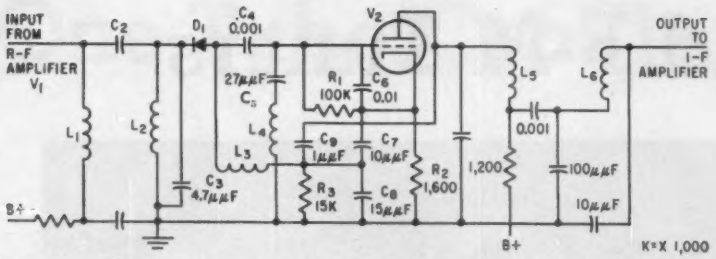


FIG. 4—Semiconductor diode mixer improves isolation of r-f and oscillator sections

the i-f signal, this method is not used; instead, cathode-to-grid feedback has been chosen. The circuit is given in Fig. 4.

The circuit of Fig. 4 operates in the following way: Tube V_2 is connected as a Colpitts oscillator employing oscillator coil L_4 in series with C_5. Feedback is provided by grid-to-cathode capacitance C_{gk} in parallel with C_6, plus the cathode-to-ground capacitance of C_7 and C_8 in series.

The oscillator signal is fed through C_4 to the mixer diode, D_1. The opposite end of the diode is connected to the top of r-f coil L_2. The i-f signal is developed across L_3, which is tuned to the i-f frequency by the capacitances of the grid circuit. These capacitances include C_5, which prevents a shorting of the i-f signal by the oscillator coil L_4. Feedback, and consequent damping of oscillation, is prevented by connecting the return-point of the i-f coil L_3 to the junction of C_7 and C_8. The values of C_7 and C_8 are chosen to give a cancellation of feedback effects. Resistor R_3 is the detector resistor for the mixer diode, and is selected to give the best compromise for matching to the r-f coil L_2 on one hand, and to the i-f grid impedance on the other.

To cancel i-f feedback effects through C_{gp} between plate coil L_5 and the grid coil L_3, a neutralizing capacitor C_9 is introduced, which feeds a signal component from the plate to the lower end of L_3. The operation of the two feedback canceling bridges can be seen from Fig. 5. This diagram shows that no direct feedback from the tube to L_3 will occur if $(C_9 + C_{gk})/C_5 = C_7/C_8$. Furthermore, no i-f feedback from plate to grid occurs if $C_{gp}/C_5 = C_9/C_6$.

Diode D_1 is a conventional video diode, type 1N87 or 1N87A. These types have proven to be satisfactory for mixer efficiency and damping, up to 250 mc.

The damping of the circuit is determined mainly by the diode resistor, thus it is approximately constant over the tv range of frequencies. Furthermore, the mixing efficiency of the diode decreases only slightly at the highest frequencies. The i-f coil is matched to the grid of V_2, which presents a higher impedance at i-f frequencies than at r-f frequencies.

The i-f gain of the tube depends upon the amplitude of oscillation, since for small grid signals the effective g_m of the tube increases and ultimately approaches the g_m of a nonoscillating tube. In general, the amplitude of oscillation will decrease at higher frequencies, thus the i-f gain and the resultant conversion gain will be proportionately raised. This is contrary to conventional mixer circuits, since they usually show a decrease in gain at higher channel frequencies, because of reduced mixer efficiency resulting from too low an oscillator signal.

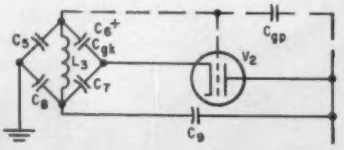


FIG. 5—Bridge balances out unwanted i-f feedback in oscillator tube V_2

This increase in conversion gain at the higher channel frequencies is an advantage. At lower frequencies a high gain value is usually less important because of higher input noise level and the generally higher r-f amplifier gain. Usually, it is the mixer gain at higher channel frequencies that sets the level of receiver performance.

Another advantage of the circuit of Fig. 4 is that the diode acts as an isolator between the oscillator and the second r-f coil, reducing the oscillator signal on this coil to some 10 db lower than in conventional mixers. The choice of the damping on i-f coil L_3 determines the contribution of this coil to the i-f selectivity; in particuler, for tv tuners (with their substantial bandwidth) L_3 is relatively heavily damped and so the feedback cancellation by the junction of C_7 and C_8 is noncritical.

For the frame grid tube 6ER5, with its relatively small plate-to-grid capacitance of 0.36 $\mu\mu$f, the neutralizing capacitor will also be small. The tube has close characteristic tolerances, permitting fixed rather than adjustable neutralizing capacitors to be used. Such capacitors could be precut from molded dual-conductor plastic wire, or from miniature coaxial cable.

The output circuit consists of tuned coils L_5 and L_6. The plate resistance of triode V_2 imposes some damping on the circuit of L_5; this must be compensated by a reduction in the damping on the coil L_6, which feeds the grid of the next stage of the amplifier.

To investigate the practical possibilities of this second type of circuit, a number of different tuners were modified by replacing the existing triode-pentode mixer with the circuit described. Tuners investigated included turret-type tuners as well as the incremental or switch-type tuners. In every case two tuners were compared, one in the original condition (the control) and one with the modified circuit.

It has to be emphasized that in converting the tuners, the characteristics of the new circuits are not demonstrated in the most favorable way. For example: in most tuner design a substantial coupling exists between the oscillator circuit and the second r-f circuit. In the original circuit this coupling is not objectionable, being an addition to the regular coupling between these two circuits. However, in the new circuits, such a coupling reduces the

Table I—Comparison of Performance of Original and Modified Tuners

Tuner	Channel	Antenna signal in mv		Total gain		Conversion gain		Total gain improvement		Oscillator signal on r-f coil	
		original	modified [a]	original	modified [b]	original	modified [c]	ratio	db	original	modified
A	2	7.75	6.25	130	160	4.5	3.3 (5.1)	1.24	2.0	3.9	0.42
Incremental tuner	6	12.5	8.0	80	125	3.65	3.65 (5.2)	1.56	3.8	3.4	0.38
using	7	12.5	9.0	80	110	3.5	5.0 (5.2)	1.4	3.0	3.4	0.14
triode	12	14.0	4.5	72	222	3.25	5.9 (6.3)	3.1	10.0	1.15	0.2
B	2	15.0	8.7	66	115	3.75	3.3	1.75	4.1		
turret tuner	6	14.0	8.75	70	115	4.1	4.0	1.65	3.8		
using	7	27.0	13.0	36.5	77	3.2	4.5	2.1	6.4		
triode	12	30.0	14.0	33	72	3.5	4.9	2.2	6.8		
C	2	20	5.0	50.0	200	6.5	12.0	4.0	12.0	2.5	0.4
turret tuner	6	20	7.5	50.0	134	6.3	11.0	2.66	8.5	2.5	1.1
using	7	18	3.8	55.5	220	6.6	17.5	4.0	12.0	1.3	0.8
pentode	12	15	3.1	65.0	310	6.5	27.0	4.75	13.6	1.4	0.5

[a] R-f input fed directly to grid of r-f stage in Tuner C to avoid gain variations due to neutralization. [b] Total gain figures for Tuner A show tendency to feedback in r-f stage caused by reduced coil damping. [c] Conversion gain results for Tuner A shown in brackets are measured direct, those unbracketed are calculated from total gain figures

isolation between the oscillator and the r-f sections—and this isolation is fundamental to the new circuits.

Another limitation is imposed by the attempt to use existing coils without greatly altering their inductance; consequently, their values will not always be the optimum ones for matching of the r-f circuit as well as for best mixer performance.

Notwithstanding the above difficulties, two types of tuner were modified with reasonable success. In each case an increased overall gain was recorded, particularly for the higher channel frequencies. This indicates the possible versatility of the new circuits.

In the modified tuners, the value of the unwanted oscillator signal developed across the second r-f coil, L_2, was 0.5 volt or less; this is on the order of 10 db lower than in the original tuners. Thus, a reduction in antenna radiation is to be expected. A more detailed comparison of the characteristics is given in Table I where results of tests on representative tuners (tuner A and tuner B) are shown.

Use of Balanced Diodes

A further improvement that may be introduced into the last group of circuits is a pair of diodes connected in a balanced arrangement. This would reduce antenna radiation and, in addition, suppress second harmonics and, hence, spurious response. A circuit using two mixer diodes is given in Fig. 6. It should be remarked that although such an arrangement would be desirable, it would probably be uneconomical for commercial television receivers.

This arrangement could be made responsive to the oscillator second and higher even-harmonics, thereby presenting some advantages when used in uhf-type tuners.

Pentode as Mixer Oscillator

At the present time, work is in progress on the use of a pentode in circuits similar to those shown in Fig. 4 but having an l-f bypass trap in the cathode. Tentative results using a frame-grid 6EJ7 pentode with a g_m of 15,000 indicate a conversion gain of 10 to 15 over the operating range, with the gain for individual channels as high as 20. This represents an increase in gain of some 2½ to 3 times the gain of the original mixer using a 6CG8A tube.

Improvements of this sort open the possibility of using a tuner of the type described with a two-stage i-f amplifier employing similar pentodes. Such a combination could be expected to give as much gain as a conventional tuner when followed by a three-stage i-f amplifier using 6BZ7 pentodes. The tentative results from this experiment are given in Table I (tuner C), which compares the performance of modified and unmodified tuners.

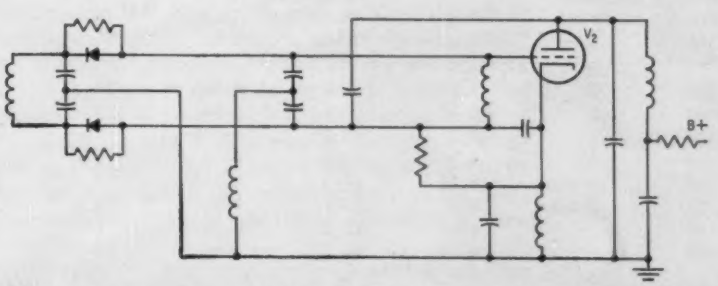


FIG. 6—Twin semiconductor diodes permit balanced mixing and better circuit isolation

Six Ways to Use Magnetic Shift Register Elements

By **JOHN PORTER**, Portronics, Inc., Tarzana, California

MAGNETIC SHIFT REGISTERS are used not only in digital computers but in a wide variety of pulse-type data handling situations. Their small size, negligible average-power consumption, low cost, ruggedness and reliability offset the disadvantage that output of most types is a narrow, triangular voltage pulse rather than a level.

Typically, a shift-resigter element consists of a toroid-shaped core with square-loop flux-magnetizing force characteristics, either of ferrite or thin metallic tape, on which are assembled two or more windings, together with one or more diodes, capacitors and a storage or delay inductor or resistor. The core has two stable states, $-B_r$ and $+B_r$, in either of which it can remain indefinitely. When switched from one stable state to the other by a polarized pulse to one winding, an output voltage is induced in the other windings. This is called a destructive readout; the amplitude of the output voltage indicates the state of the core before being switched.

The operation of a typical core-diode element such as that shown in circuit *I-A*, will be explained. A positive-going output pulse first charges the capacitor through the diode; the storage network delays the capacitor discharge until the shift pulse subsides; if the next core is in the $-B_r$ state, the pulse from the capacitor switches the core to the $+B_r$ state. Because the switching takes a relatively long time, the voltages induced in the windings of the second element are smaller than the original output pulse.

If the core is already in the $+B_r$ state when the shift pulse is applied, the output will be even smaller. For the $-B_r$ state representing a ZERO, and the $+B_r$ a ONE, the ONE-to-ZERO output ratio is often used as a figure of merit. Core-diode units have ratios of about 7 to 1, and core-transistor elements have ratios of about 15 to 1 or more. The maximum operating frequency is set by the core and the storage network.

Generally, the elements are packaged into small rectangular blocks, with the components assembled on a base plate and the whole unit potted for hermetic sealing. Pin connections on the base plate are arranged for either etched wiring boards or miniature tube sockets. Volume of some high-frequency units may be as low as 1/8 cu. in., while small-quantity costs range from $5.50 to $16.00 per element, depending on circuit and highest operating frequency.

Advances in the design of sophisticated, yet simpler, shift register elements can be expected from increased understanding and application of the devices. The twistor and a special magnetized glass rod, where digital data are shifted along the length of the device, are expected to contribute to the art.

Characteristics of some commercially available shift registers are given in Table I.

A brief description of each of the element types shown on p 81 follows; the typical element itself is shown enclosed in dashed lines.

CIRCUIT I-A—The core-diode configuration has been covered in the discussions above. The diode may be internal or external and may be associated with either the serial-input or serial-ouput winding.

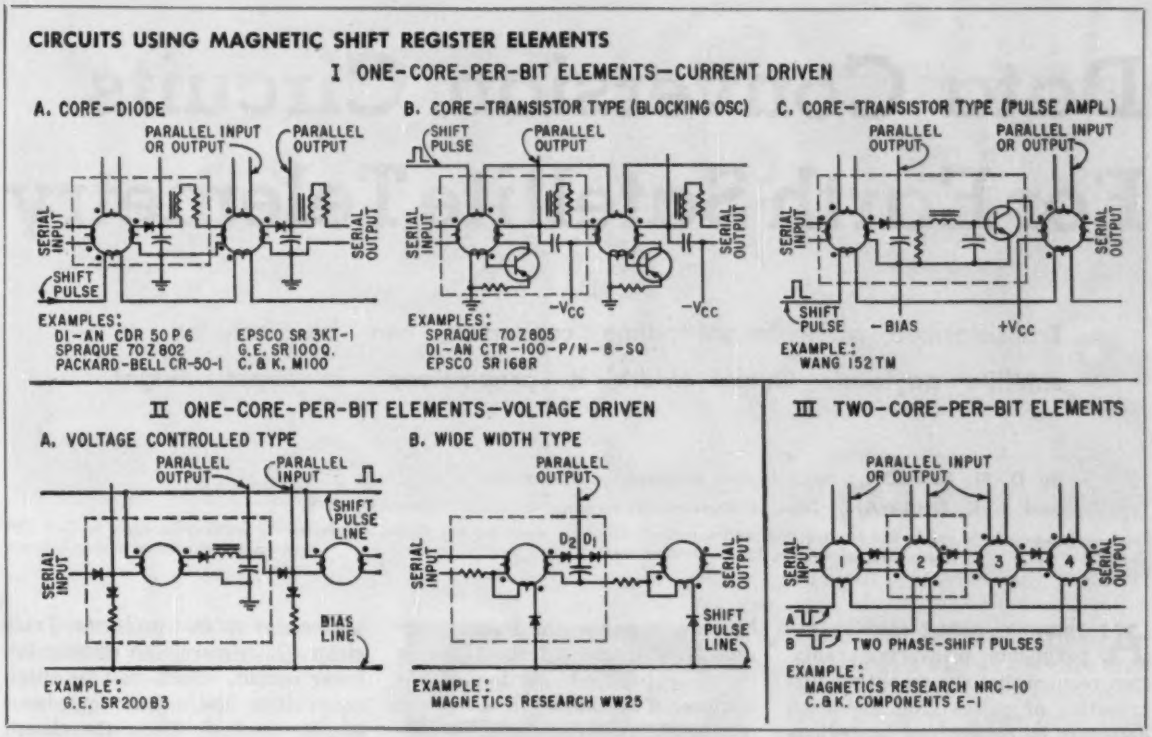
CIRCUIT I-B—The core-transistor technique has the advantages of lowered shift-current require-

Table I—Tabulation of Typical Magnetic Shift Register Elements

Type of Element	Shift Current Ma	Shift Width μSec	Power Watts	Signal Noise Ratio	Freq Range kc	Output Voltage	Min Load Z
Core-Diode, Current Operated.....	220	1.2	1.4	8:1	0–200	15	10K
	1300	3.5	0.07	8:1	0–50	8	5K
Core-transistor, Blocking Osc.....	100	0.5	0.2	15:1	0–250	V_{cc}[b]	2K
	200	1.3	0.2	10:1	0–50	V_{cc}[b]	——
Core-transistor, Pulse Ampl.....	75	1.0 Min	0.15	——	0–250	2.5	——
Core-Diode, Voltage Controlled...	25	1.5 Min[a]	0.2	10:1	0–200	0.3	47K
Core-Diode, Wide Width.....	100	8[a]	1.7	10:1	0–25	6	5K
Two Core per Bit.....	100	10	0.45	——	0–35	12–24	30K

(a) Upper limit determined by operating shift rep rate

(b) Output voltage determined by supply voltage



ments and improved ONE/ZERO ratio. The transistor is arranged as a triggered blocking oscillator so that a minimum shift pulse produces one cycle of regeneration, yielding a parallel output pulse equal in amplitude to the supply voltage. If the core is in the ZERO state when the shift pulse arrives, regeneration does not take place. Since large amplification is possible, this circuit is sometimes used with ferrite cores to augment their normally low voltage output.

CIRCUIT I-C—Occasionally a transistor is used to amplify the delayed output pulse from the temporary storage network, thus improving the ONE/ZERO ratio. The transistor is biased to a threshold slightly beyond the ZERO level so that only ONE's are transferred.

CIRCUIT II-A—The voltage-controlled element is one of a new family of devices intended to facilitate the design of shift-register drivers and readout devices. Shift pulses from a constant voltage source, such as an emitter-follower, are applied to all elements in parallel. A reverse-biased diode to each element normally keeps the shift-pulse line at a high impedance and the shift pulse must be large enough to overcome this bias. The diode in the element output line is thereby gated so that all energy accumulated on the capacitor is available for shifting data. The core switches during the first microsecond or so of the shift pulse and is effectively disconnected for the rest of the pulse. Thus the minimum width of the shift pulse is that of the switching time of the core; the maximum width is limited by the shifting rate.

CIRCUIT II-B—The wide-width element is another technique developed for transistor drivers. Shift pulses from a constant voltage source are applied to all cores in parallel. During the pulse the voltage on the capacitor, which is charged through diode D_2, backs the voltage across the resistor in the coupling circuit. Therefore the parallel output pulse is essentially as wide as the shift pulse, and the only requirement on shift-pulse width is that it be off long enough to allow the capacitor to discharge through D_1 and hence condition the succeeding core.

CIRCUIT III—The two-core-per-bit elements have a simple interelement coupling network but need a two-phase driver. In essence, core 2 acts as temporary storage for a ONE being shifted from core 1 by shift pulse *A*. Shift pulse *B* restores core 2 and causes it to condition core 3. A pulse on *A* and then on *B* is required to shift a ONE from core 1 to core 3, and the diode effectively isolates a given core from the preceding core.

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Data Conversion Circuits For Earth Satellite Telemetry

Transistorized pulse height-to-time converters can be included in satellite payload. Output width is proportional to input height

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AT PRESENT, EARTH satellite experiments measuring radiation require that the amplitude distribution of pulses from radiation detectors be determined by tedious manual reduction of telemetered data. This time consuming work can be eliminated by including a complete pulse height analyzer as part of the satellite payload. Thus, the telemetered data would directly contain the amplitude distribution of detected radiation over a given period of time. Poor signal-to-noise and other problems preclude the use of an analyzer on the ground.

Key portion of the analyzer is a circuit which converts pulse heights to widths or time. The time pulse controls an oscillator, which gives a number of cycles of output directly proportional to the height of the input pulse. Output information may then be stored in some type of memory so that the number of pulses of each amplitude occurring in a given period of time may be determined. Such an analyzer (using vacuum tubes and mechanical registers) was first described by D. H. Wilkinson in 1950.[1]

Linearity of the analyzer depends upon the linearity of height-to-time conversion and the oscillator stability. The oscillator can be easily stabilized. However, linear conversion of height-to-time over a reasonable range of input pulse amplitude is not easily accomplished. Furthermore, when using semiconductor devices, as dictated by satellite requirements, the leakage current is particularly troublesome in the height-to-time portion of the analyzer. Two simple circuits which provide linear conversion are discussed.

The schematic diagram of what will be referred to as the constant current charge circuit[2] (CCC circuit) is shown in Fig. 1. This circuit accepts negative input pulses of up to 40 v in amplitude. Transistor Q_1 is used to charge capacitor C_1 at constant current. Transistor Q_2 and associated diodes make up the comparator.

It should be noted that the voltage comparison is made only at the instant C_1 is recharged, thus reducing leakage current problems. Transistor, Q_3, is merely an emitter follower output, which may be eliminated if a low output impedance is not required. Thus, the circuit performs the required function with just two transistors, Q_1 and Q_2. Direct connection between stages greatly simplifies the biasing and eliminates components.

Table 1—Specifications for Constant Current Charge Circuit

Output pulse amplitude: 8 v (25 v without D_4).
Output pulse rise time: less than 4 μsec.
Output pulse fall time: less than 2 μsec.
Output pulse width: 415 μsec with 40 v input pulse.
Linearity: within 3.23 percent for input pulse amplitudes of 1 to 40 v and within about 1 percent for input pulse amplitudes of 1 to 30 v.
Temperature stability: stabilized from −30 C to +100 C.
Voltage Supply: +25 v and −4 v.

CCC Operation

Under quiescent conditions, the approximately 200 μamp of current available from Q_1 is used to supply the base current of Q_2. The collector load resistance of Q_2 is selected so that the collector is saturated under these conditions. Upon application of a negative input pulse, C_1 is charged to the peak value of the pulse through diode D_1. In order for C_1 to charge faithfully, the rise time of the input pulses must be longer than the charging time constant of D_1 and C_1.[1] As soon as C_1 has been discharged (charged negatively) by the input pulse, diode D_2 is reverse biased, cutting off the base current to Q_2. After the input pulse has disappeared, the 200 μamp of current begins to recharge C_1. Diode D_1 isolates C_1 from the pulse source during the ramp generation.

Since the base current of Q_2 is reduced to zero by the reverse bias on D_2, the collector current of Q_2 cuts off and the collector rises to the full supply voltage of +25 v. When the ramp amplitude reaches

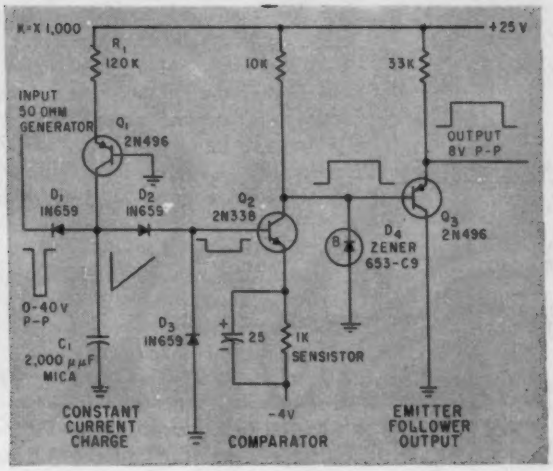

FIG. 1—Last stage of constant current charge circuit can be eliminated if output impedance can be high

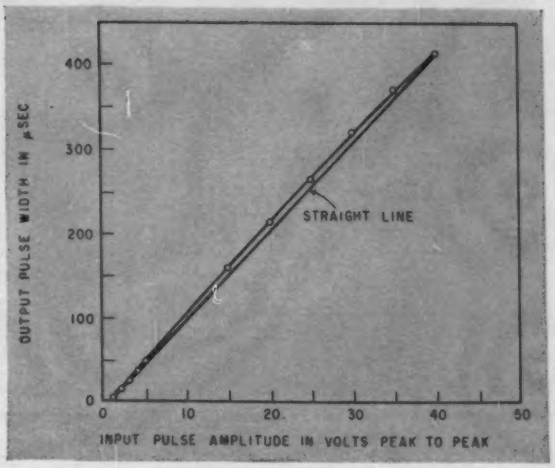

FIG. 2—Comparison with straight line shows a maximum departure from linearity of 3.2 percent for CCC circuit

the point where D_2 is once more conducting, the collector of Q_2 is again saturated.

A large amplitude (25 v p-p) rectangular pulse appears on the collector of Q_2. The width of this pulse is linearly related to the input pulse amplitude.

Zener diode D_4 is used to clip the output pulse to about 8 v p-p. In many applications it might be desirable to differentiate the output pulse for triggering purposes; in this case, D_4 can probably be eliminated. Diode D_3 may also be eliminated since its only function is to make it easier to adjust the nominal −4 v supply to the optimum value for biasing D_2.

Linearity

The linearity of the circuit is shown in Fig. 2. A straight line has been drawn between the end points to show the departure from exact linearity over the complete range of input pulse amplitudes. Maximum departure from linearity is 3.2 percent. If the input pulse amplitude range is restricted to 1-30 v, the linearity improves to about 1 percent. Obtaining input amplitudes this large with transistors presents problems. Unfortunately, the linearity below 1-v input could not be measured accurately. Improved methods of measuring the linearity, particularly at small input pulse amplitudes, are required.

Temperature stabilization of the CCC circuit was accomplished by using silicon diodes and transistors. In addition, a Sensistor is used in the emitter of Q_2 (Fig. 1). With these simple expedients, the upper limit of operation was between 100 C and 120 C, while the lower limit was between −30 C and −40 C.

Effect of temperature on linearity was not investigated because it was felt that as long as the output pulse width was stable for a fixed-amplitude input pulse, the linearity probably was not affected. Attempts at stabilization by control of R_1 were not examined.

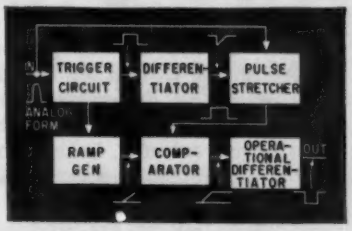

FIG. 3—Block diagram of stretcher shows waveform at various points

Pulse Stretcher

Another approach[3] to the problem of providing linear conversion of height-to-time is shown in Fig. 3 and 4. In this circuit, which accepts positive pulses up to 7 v in amplitude, D_1, D_2 and C_1 stretch the input pulse for a fixed period of time while preserving the amplitude. Transistors Q_1 and Q_2 form a monostable multivibrator which is used for delay and triggering.

Diode D_3 is used as a voltage comparator, the stretched input pulse being compared to the ramp from the bootstrap ramp generator, Q_3. Comparison is made only when the magnitude of the ramp reaches the stretched pulse amplitude. Transistor Q_4, an operational differentiator, provides a rectangular output pulse, the width of which is directly proportional to input pulse amplitude.

Stretcher Operation

The positive input pulse triggers the monostable multivibrator (Q_1 and Q_2), which gives a positive-going pulse of 20 v at the collector of Q_2 and a negative-going pulse of 4 v at the collector of Q_1. Time duration of these pulses (68 μsec) is several μsec greater than the widest output pulse required. The extra delay gives better comparator output pulse shape. The input pulse also charges storage capacitor C_1 through D_1 to its full voltage, minus the 0.3 volt drop across D_2. During the stretching period of 68 μsec, D_1, D_2 and D_3 are reverse biased.

The 20-v positive pulse from the collector of Q_2 is differentiated by C_2, C_3, R_1 and R_2. A low impedance path is provided for positive pulses by D_4, and the negative pulse discharges C_1 after the 68-μsec delay.

The ramp generator is gated by the 4-v negative pulse from the collector of Q_1. Normally, Q_3 and Q_4 are conducting, grounding C_4. When the negative pulse is applied to its

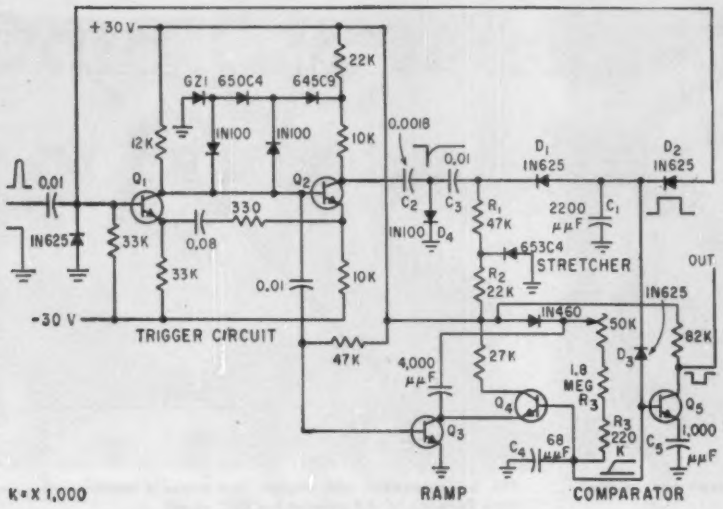

FIG. 4—Output of pulse stretcher circuit is used to control an oscillator

base, Q_2 cuts off. Capacitor C_4 starts charging at constant current because of the bootstrap action. The ramp is applied to the anode of D_3, while the stretched pulse is applied to its cathode. When the amplitude of the ramp is 0.3 v greater than the stretched pulse, D_3 conducts, thus bypassing most of the charging current of C_4.

The comparator waveform is differentiated in the emitter follower differentiator Q_5. Because of the emitter follower arrangement, the emitter follows the base. Because of C_5, the current that flows in the emitter of Q_5 (hence in the collector of Q_5) is the derivative of the base voltage. The negative output pulse appears at the collector of Q_5 and may be differentiated for triggering purposes.

Linearity and Stability

Silicon transistors and diodes are employed in the pulse stretcher circuit. Preliminary measurements indicated that the linearity of height-to-time conversion is of the order of 0.1 percent over a temperature range of −40 C to + 50 C.

Nonlinearity introduced at elevated temperatures is caused by the ramp generator and diodes D_1, D_2 and D_3. Diodes D_1 and D_2 do not affect the stretcher voltage waveform up to +75 C, but the comparator works over a more limited range of −40 C to +50 C. It is not necessary to compensate the ramp generator since temperature-dependent changes in the current through R_3 are balanced by opposite changes in the leakage current. Thus, the charging current of C_4 is kept constant over the temperature range mentioned.

Amplitude sag in the stretcher itself (because of a finite leakage time constant) does not seriously affect the operation of this circuit. Voltage across C_1 is a linear function of time during the stretching period, and, therefore, does not affect the linearity of the height-to-time conversion.[3]

Applications

Both circuits are designed to provide linear conversion of pulse height to time within the limitations of their specifications. Specifications are shown in Tables I and II. These circuits were designed to accept input pulses with rise times of 1 to 2 μsec. For other rise times the charging time constant for the storage capacitors (C_1 in Fig. 1 and 4) have to be changed.

Table II—Specifications For Pulse Stretcher Circuit

Output pulse amplitude: about 25 v.
Output pulse rise time: 2 μsec.
Output pulse fall time: 1 μsec.
Output pulse width: 64 μsec with 7 v input pulse.
Linearity: 0.1 percent for input pulse amplitudes up to 7 v.
Temperature stability: stabilized from −40 C to +50 C.
Voltage supply: ±30 v.

Possible applications include pulse width modulation systems, as well as pulse height analyzers as considered here.

Since the height-to-time converter is normally synchronized so that the oscillator controls the start of the digital output, the leading edge of the time pulse is not important in this application.

In the CCC circuit (Fig. 1) the collector-to-emitter voltage rating of the 2N496 is exceeded when large amplitude pulses are applied. The short duty cycle apparently protects this transistor from damage, but use of another type transistor is desirable for critical applications.

In general, the circuit shown in Fig. 1 would be most useful where the higher amplitudes required would not present a problem. It offers simplicity, good linearity, and good temperature stabilization. The pulse stretcher circuit of Fig. 4 would prove useful where lower amplitude pulses must be converted to time information. This circuit offers somewhat increased complexity, but provides very good linearity and reasonable temperature stability.

In both circuits, particularly the CCC circuit, improved methods of linearity and jitter measurements are desirable.

This work, performed in the Cosmic Ray Laboratory of the State University of Iowa, Department of Physics, was supported in part by the Office of Naval Research. The authors gratefully acknowledge this aid and that of the staff members of the Physics and Electrical Engineering Departments.

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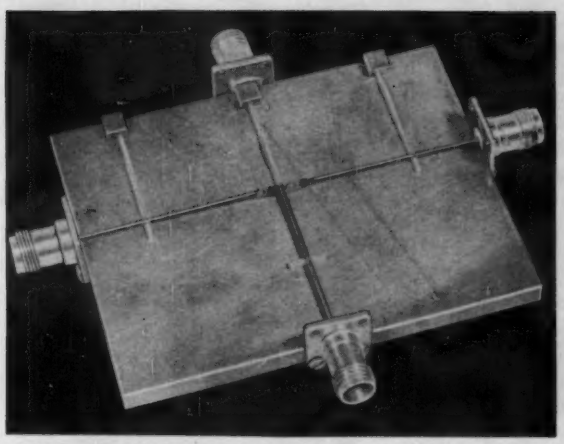
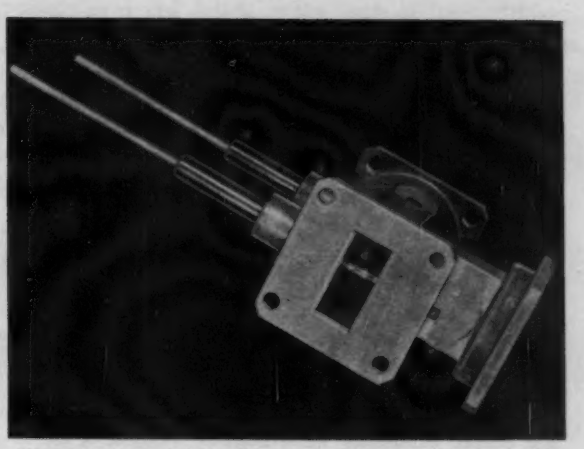


Typical spdt microwave switch with one ground plane removed. Crystals are mounted close to r-f input arm of Tee



Waveguide Tee switch showing one crystal mounted in waveguide and variable short-circuited stubs used to tune crystals

Microwave Switching With Computer Diodes

Biasing techniques permit electronic switching of microwaves with small-area junction diodes. Series of spdt switches are formed by mounting germanium diodes in waveguides or transmission lines

By **M. BLOOM,** Sylvania Electronic Systems Div., Sylvania Electric Products, Inc., Waltham, Mass.

MICROWAVE SWITCHES that utilize the high-frequency characteristics of small-area junction germanium diodes are described. Since no mechanical drives or contacts are required the switch will operate at high speeds with long life expectancy.

Switches for 1 to 10 kmc have been designed. X-band switches covering 7 to 10 kmc are fabricated in rectangular waveguide; all others in a type of coaxial transmission line (slabline).

Spdt and spst switches have been made. The spdt type is useful for low-level duplexing, time sharing or to switch r-f at high speeds.

Crystal switches offer smaller size, lower weight, faster switching and lower drive power requirements than mechanical or ferrite elements. Many crystal diodes were studied to determine their r-f characteristics and switching ratios. As a result, it is possible to choose them with only a knowledge of their r-f impedance.

Earlier Switches

Past designs include: an X-band switch using a 1N263 microwave germanium diode[1, 6] an S-band coaxial switch using 1N91 germanium diodes[3]; and a switch in which a microwave crystal detunes a resonant circuit.[2] Some work has also been done by Uhlir on the use of diodes at high frequencies.[7] While all these switches are compact and require low drive power, they are not capable of double-throw operation over greater than octave bandwidths.

Crystals Tested

Silicon and germanium crystals of both microwave and computer types were tested for r-f impedance, insertion loss and switching action. Rectifiers and large area junction diodes were excluded because of their relatively long switching time[8].

Result indicated that certain computer-type germanium diodes with high front-to-back ratios and low forward resistances would attain high r-f switching action. Since most of the previous work had apparently concentrated on microwave crystals exclusively, this result was not discovered. The 1N419 was selected for X-band and the 1N118 for all lower frequencies.

Because these computer crystals have larger current-handling capability and higher reverse breakdown voltage than microwave diodes, it is possible to switch at higher r-f power levels. Tests conducted on the X-band waveguide switch at power levels up to 4 watts c-w showed no significant degradation of switching or insertion loss characteristics. (See Fig. 1.) A coaxial switch has also been tested at 1 watt c-w with compar-

able results. (See Fig. 2.) It is expected that these crystal switches will operate at even higher powers, but this property has not been investigated and verified experimentally.

Switch Theory

From the impedance data of the 1N118 crystal shown in Fig. 3, it can be seen that in the reverse-biased condition the crystal appears as a large capacitive reactance which decreases with increasing frequency. This impedance approximates that of a capacitive gap in the center conductor of a coaxial line. In the forward-biased condition, the crystal impedance can be approximated by a short length of 100-ohm coaxial line inserted in a 50-ohm coaxial line. Generally, the r-f impedance of the crystal in the forward-biased condition is dependent on the ground plane separation of the slabline. To achieve the 100-ohm impedance, it is necessary to construct the slabline with small ground plane spacing—in this case 0.110 in. Diameter of the center conductor is chosen accordingly.

When the crystal is inserted in series with the center conductor of a coaxial line and biased in the forward direction, it exhibits a small insertion loss; when biased in the reverse direction, a large insertion loss is obtained as shown in Fig. 4. The insertion loss in both cases results mainly from reflective losses with very little r-f power being absorbed by the crystal.

Insertion loss in the forward-biased condition increases slightly with frequency and insertion loss in the reverse-biased condition decreases with frequency. (See Fig. 4.) Insertion loss and switching of a given crystal can be calculated from the r-f impedance of the crystal; also, the frequency dependence of insertion loss and switching loss can be predicted. Switching loss is difference between reverse-biased and forward-biased insertion loss.

Operation and equivalent circuit of a crystal mounted across a waveguide through the broad face has been treated in other articles[4]. Basically, the crystal is considered as a series R-L-C circuit as in Fig. 5.

When the crystal is biased in the forward direction, barrier resistance R_b is small and effectively shunts the capacitance. The crystal then appears as a high impedance because of the series R-L circuit shunting the waveguide. This condition results in a small mismatch and a small insertion loss.

When biased in the reverse direction, R_b is very large, but it is shunted by the capacitive reactance. The equivalent circuit of the crystal then becomes a series R-L-C circuit with a small value of R. At resonance, the crystal is a very low r-f impedance shunting the waveguide similar to a short circuit. A large mismatch and insertion loss result as shown in Fig. 6.

Resistance makes the crystal a low-Q circuit. The switch operates favorably over about 500 mc centered at a resonant frequency determined by the crystal parameters.

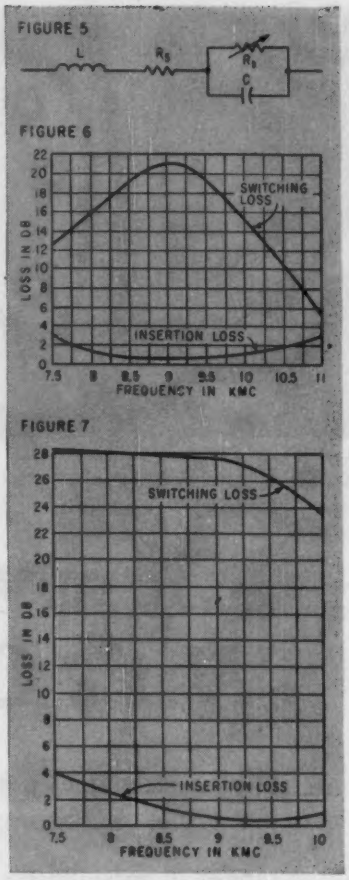


FIG. 5—Equivalent circuit of diode mounted across rectangular waveguide

FIG. 6—Switching and insertion losses as function of frequency of series switch. IN419 is mounted in RG-5R/U waveguide

FIG. 7—Switching and insertion losses as functions of frequency of series switch on IN419 mounted in RG-52/U waveguide. Switch is tuned at each measured frequency for maximum switching loss

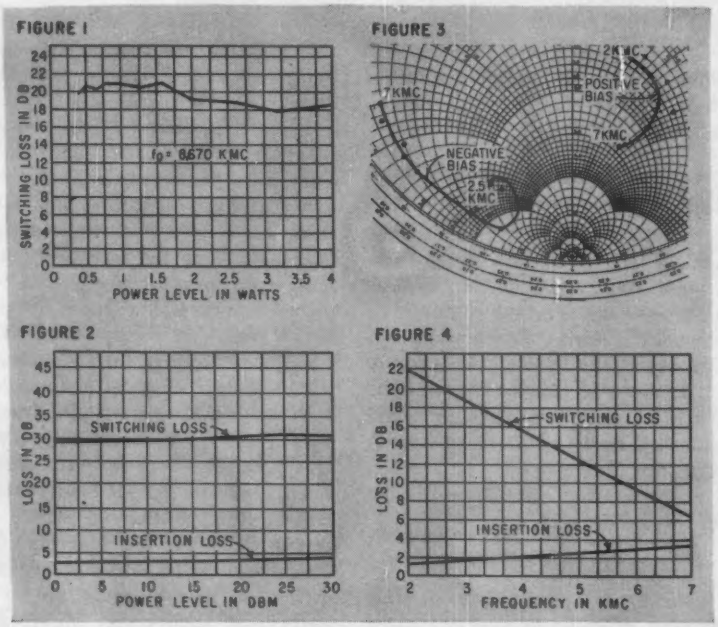


FIG. 1—Switching as function of power for untuned waveguide switch using single IN419 crystal. Insertion loss remains constant. FIG. 2—Switching as function of power for coaxial Tee switch using two IN118 crystals per arm. FIG. 3—Impedance of single IN118 crystal mounted in 50-ohm slabline. Impedance is referred to center of crystal. FIG. 4—Switching and insertion losses as a function of frequency in a series switch. Single IN118 crystal is in series with center conductor of slabline

To switch at other frequencies, it is necessary to use a different crystal or tune the existing crystal.

A short-circuited coaxial line in series with the crystal adds reactance. Varying this reactance changes resonant frequency as in Fig. 7. To decrease frequency, inductive reactance is added; to increase frequency, capacitive reactance is added. Both slightly increase pass-power insertion loss. Switching and insertion loss can also be predicted from crystal impedance. (See Fig. 8.)

SPDT Slabline Switch

A single crystal placed in the center conductor of a coaxial line will switch r-f power; however, in doing so a large vswr is encountered in the stop-power condition. By placing one crystal in each arm of a slabline Tee it is possible to switch r-f power alternately between two loads.

In addition, if the crystals are placed at the junction of the Tee, or an integral number of half wavelengths away, the input vswr will be that of a single crystal biased in the forward direction. This impedance is seen in either condition of the switch. Slabline is used for simplicity of constructing d-c returns and ease of fabrication.

SPDT Wideband Switch

The two crystals are connected in series with a voltage applied at the connection. The outside ends are grounded by d-c returns.

When a positive voltage is applied to the crystals, one crystal is biased in the forward direction and the other in the reverse direction. The crystal biased in the reverse direction approximates a short length of 100-ohm line.

R-f power is transmitted through the forward-biased crystal with a small insertion loss while very little power will be transmitted through the other crystal. If the applied voltage is reversed, biasing of each crystal is reversed and r-f power is switched to the other output.

With the crystals mounted at the junction of the Tee, reliable operation is obtained over octave bandwidths with approximately the same changes in insertion loss and switching as with a single crystal. At higher frequencies, where gap reactance has decreased considerably, it is necessary to replace each single crystal by two crystals in series to preserve the high switching characteristics. (See Fig. 9.)

SPDT Waveguide Switch

As frequency increases, crystal length becomes an appreciable portion of a wavelength. When forward biased, insertion loss increases because of length of the high-impedance line; when reverse biased, gap reactance and switching decrease. A switch in waveguide has similar characteristics to a slabline switch except that it has smaller bandwidth (about 5 percent).

A waveguide Tee switch can use an H or E-plane Tee. Crystals are mounted in the broad face of the guide in the plane of the continuation of the walls at the junction or an integral number of half wavelengths away.

Operation is similar to the slabline switch although two separate bias supplies are required. The crystal biased in the reverse direction approximates a short circuit across one arm of the Tee and a high insertion loss results, while the other crystal transmits r-f with small insertion loss. Bandwidth is limited because of the crystal tuning requirement and the necessity of placing crystals at a half wavelength from the junction.

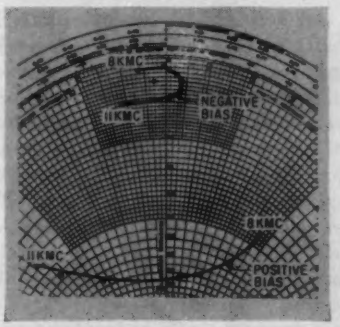


FIG. 8—Impedance of IN419 crystal mounted in RG-52/U waveguide. Impedance is referred to center line of crystal

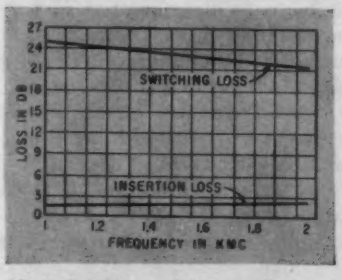


FIG. 9—Switching and insertion losses of slabline Tee switch with a single IN118 crystal in each arm of Tee

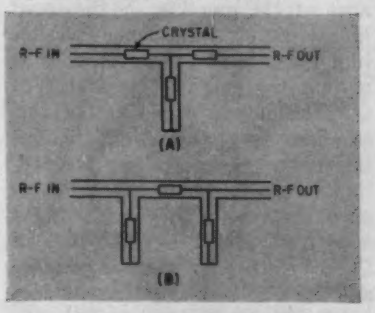


FIG. 10—Single-throw Tee switch (A) and single-throw π switch (B)

Other Switch Devices

Other switches were made by inserting a diode in series with the center conductor of a coaxial line. L, Tee and π configurations were made with crystals in series with each arm, as in Fig. 10.

These switches are basically single-pole single-throw types that are capable of larger switching values than a single crystal. The crystals in the shunt arms are biased in the reverse direction and the series crystals are biased in the forward direction.

Another switch was designed using a zero-db coupler and placing crystals in series with the center conductors of two arms. It resulted in narrow-band switching[8].

Crystal switches also operate as pulse modulators with rise time of 0.05 μsec or less, electronically variable attenuators, power dividers, duplexers — wherever high-speed variation of low-level r-f is required. It should be possible to extend power-handling ability and frequency range.

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Low-Pass Filter for

Low-pass filter uses three transistors and solid tantalum capacitors for a flat frequency response from d-c to the 1 cps cutoff frequency, attenuation slope of 15 db per octave, near zero insertion loss and good temperature stability

By **R. C. ONSTAD,** Senior Electronics Engineer, Convair-Astronautics, San Diego, Calif.

DUE TO THE limited number of higher response channels available on a missileborne telemeter it is often necessary to commutate signals that have frequency components greater than one-half the sampling rate. According to sampling theory, in order that the multiplexer shall not superimpose interfering sidebands on the signal, it is necessary to insert a low-pass filter between the signal source and the multiplexer.[1]

Assume the signal requiring the filter is sampled at a 5-cps rate and has useful frequency components up to 1 cps and undesirable responses at 4.5 cps and higher. Because of the frequency characteristics of the signal, primary design objectives for the filter are for a 1 cps corner frequency and sufficient steepness of attenuation slope in the stop band so that the attenuation is 26 db or greater at 4.5 cps. Other criteria are for a flatness in pass band within 1 db, a d-c insertion loss not greater than 1 db and output impedance not greater than 10,000 ohms. The input signal voltage range is zero to 5 volts and signal source impedance is 4,000 ohms.

The required filter characteristics as defined by the above requirements are such that the filter should have a maximally flat frequency characteristic. Space and power supply limitations rule out a filter containing inductances or vacuum tubes. A passive RC filter would be unsatisfactory because of the insertion loss, output impedance and frequency characteristic requirement. The development of an active RC filter incorporating a highly stable simple transistor feedback amplifier and RC networks was the solution to the problem.

Amplifier Design

An active filter based on Fig. 3 (within the panel) has been developed for vacuum tubes using a gain stage and a cathode follower[2] A similar approach using a transistor in an emitter-follower configuration might be used. A d-c coupled emitter follower produces zero offset and introduces considerable drift with temperature. The amplifier incorporated in the filter has the desired characteristics of stable gain, zero d-c offset, low-temperature drift, high input impedance and low output impedance. The basic circuit diagram of this amplifier is shown in Fig. 4. In this circuit, drift is minimized by using a balanced input to transistors Q_1 and Q_2. The signal is direct coupled from Q_1 to Q_2 through the direct-connected emitters. The amplified signal on the collector of Q_2 is coupled to the output through emitter follower Q_3. Unity closed-loop gain and feedback ratio results from connecting the output directly to the base of Q_2. The input impedance of the amplifier is the input impedance of the common-collector input transistor and approaches as a limit the collector resistance of Q_1. The output impedance of this amplifier is essentially the output impedance of an emitter follower that has as its input a zero impedance generator. Due to the tight negative feedback loop the base of Q_2 sees essentially a zero impedance and the amplifier output impedance is less than 100 ohms.

There are three principle sources of zero drift due to temperature. Zero drift can result from variations in the d-c supply voltages. Maximum drift occurs when the plus and minus supply voltage are both changing in the positive direction or vice versa. Under this condition a change of 1 percent in each power supply causes a zero drift of 14 millivolts at the output.

Another source of zero drift is due to a shift in the emitter voltage —collector current transfer characteristics of transistors Q_1 and Q_2. This shift in parameters of Q_1 results in a zero drift that is cancelled by a corresponding shift in the parameters of Q_2 due to the rejection of common-mode signals that is characteristic of the differential circuit incorporated in this amplifier. The drift due to this source can be minimized if required, by using transistors that are matched with respect to temperature characteristics and are connected by a good thermal conductive path.

A third source of temperature drift is the variation with temperature of the input current of Q_1. This produces a zero drift at the input to the amplifier that is directly proportional to the source resistance of the input signal. If signal source resistance is of a value such that zero drift introduces significant error, compensation must be employed. If base current of Q_1 (Fig. 4) is plotted as a function of temperature it is found that a fairly linear plot is obtained over the temperature range of 0 to 100 C. The magnitude of current at a given temperature will vary for different transistors but the slope of the plot

Subaudio Frequencies

ACTIVE NETWORK THEORY

The filter network used is essentially a cascaded RC filter with feedback. Consider a two-section RC filter to give an attenuation slope of 12 db per oc-

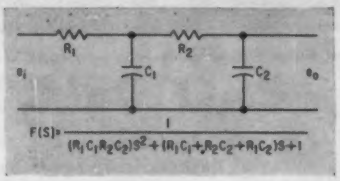

FIG. 1—Basic two-section RC filter with transfer function used in filter

tave. The two-section RC filter in cascade shown in Fig. 1 has a transfer function which equals

$$\frac{1}{\left[\frac{S}{\sqrt{\frac{1}{R_1C_1R_2C_2}}}\right]^2+\left[\frac{S}{\sqrt{\frac{1}{R_1C_1R_2C_2}}}\right]\left[\frac{R_1C_1+R_2C_2+R_1C_2}{\sqrt{R_1C_1R_2C_2}}\right]+1} \quad (1)$$

which equals

$$1/[(S/\omega_0)^2+(S/\omega_0)\,2\,\xi+1] \quad (2)$$

where

$$\omega_0 = \sqrt{1/R_1C_1R_2C_2}$$

and

$$2\xi = R_1C_1+R_2C_2+R_1C_2/\sqrt{R_1C_1R_2C_2} \quad (3)$$

The shape of the frequency characteristic of $F(S)$ is dependent only on the value of the parameter ξ (see Fig. 2). The constant ω_0 determines the position of the corner frequency in the frequency domain. From equation 3

$$\xi = R_1C_1+R_2C_2+R_1C_2/2\sqrt{R_1C_1R_2C_2} \quad (4)$$

Assuming

$$R_1C_1 = R_2C_2 = RC$$

Then

$$\xi = \frac{2\,RC+R_1C_2}{2\,RC} = 1+\frac{R_1C_2}{2\,RC} \quad (5)$$

Equation 5 shows that the shape of the curves obtainable is restricted to those shapes corresponding to $\xi > 1$. These curves do not possess the more desirable frequency characteristics. When feedback is used, it is possible to obtain curves corresponding to $\xi < 1$.

Consider the original two-section RC filter inserted in the forward path of any amplifier with a gain K. The transfer function of a feedback amplifier of gain K and feedback factor β can be shown to be

$$1/(\beta + 1/K) \quad (6)$$

This transfer function is modified by the insertion of a two-section RC filter as shown in Fig. 3 so that

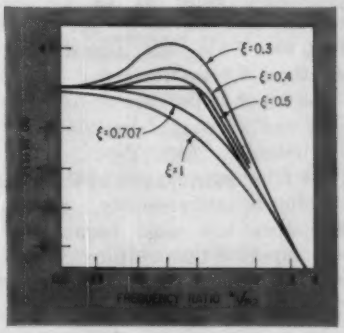

FIG. 2—Shape of the frequency characteristics is dependent on ξ

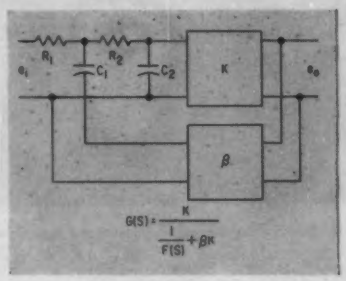

FIG. 3—Two-section RC filter is inserted in forward path of amplifier

$$G(S) = \frac{1}{\beta+1/KF(S)} = \frac{K}{1/F(S)+\beta K} \quad (7)$$

Where $F(S)$ is the transfer function of the two-section RC filter. Substituting equation (1) for $F(S)$.

$$G(S) = K/(R_1C_1R_2C_2)S^2+(R_1C_1+R_2C_2+R_1C_2)S+1+\beta K \quad (8)$$

The new values of ω_1 and ξ_1 are

$$\sqrt{\frac{1+\beta K}{R_1C_1R_2C_2}} \text{ and } \frac{R_1C_1+R_2C_2+R_1C_2}{2\sqrt{(1+\beta K)\,(R_1C_1R_2C_2)}} \quad (9)$$

Assuming $R_1C_1 = R_2C_2 = RC$

$$\xi = \frac{2\,RC+R_1C_2}{2\,RC\sqrt{1+\beta K}} = \frac{1+[R_1C_2/2\,RC]}{\sqrt{1+\beta K}} \quad (10)$$

There is now means of adjusting ξ_1 to any value from $1 + [R_1C_2/2\,RC]$ corresponding to $\beta = 0$, see equation (5), to

$$\frac{1+[R_1C_2/2\,RC]}{\sqrt{1+\beta K}}$$

to obtain any set of curves within the limits of β and K.

for various transistors will agree quite closely. Compensation in the form of a resistance and thermistor network between the positive voltage source and the base of the transistor to be compensated provides a current of equal but negative slope to reduce the zero drift at the amplifier input from 1.6 millivolts/degree C to 0.4 millivolt/degree C over the range of −25 to +80 degrees C.

Active Filter Design

The 12 db per octave filter of Fig. 4 incorporates a two-section RC network and a temperature compensated amplifier. This feedback filter can be designed to have a response that very closely approximates the maximally flat frequency characteristic. The frequency characteristic is determined by the amount of feedback voltage as selected by the ratio of R_3 to R_4 and by the ratio of R_1C_1 to R_2C_2. A close approximation of corner frequency is $1/2\,\pi\sqrt{[1/R_1\,C_1\,R_2\,C_2]}$. The values of R_1 and R_2 should be made as small as possible to limit temperature

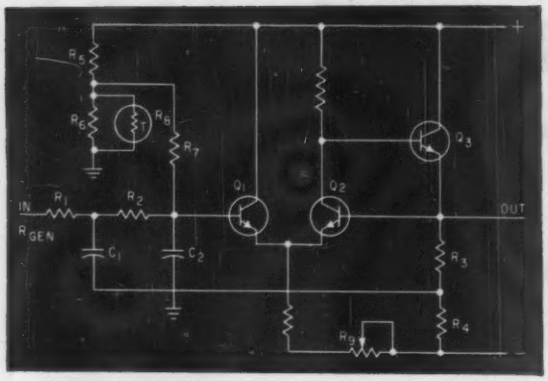

FIG. 4—Basic filter-amplifier uses three transistors

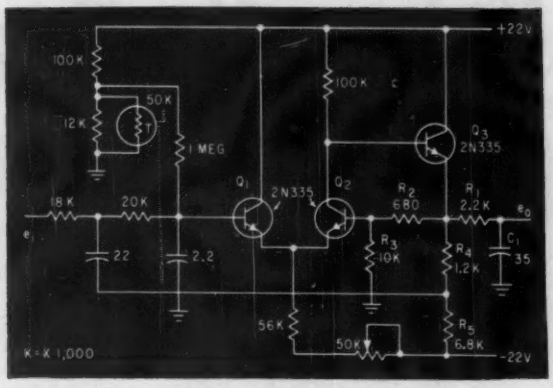

FIG. 5—Output of final design filter-amplifier uses passive RC section

drift. The temperature compensation network is made up of resistors R_5, R_6 and R_7 along with thermistor R_8. This network can be designed after the values of R_1, R_2 and R_{gen} are known. The filter is designed to accommodate an input signal that varies from 0 to + 5 v. Limiting occurs with negative signals that are greater than −1.5 v. Potentiometer R_9 is an adjustment for d-c zero set. This adjustment is set for zero d-c at the output with the input grounded.

The ultimate filter design which meets the particular requirements for a filter to precede a 5-rps commutator consists of an active filter cascaded with a passive RC network. Although the passive network may be placed either ahead of or after the active filter, it follows the active filter because input conditions are unchanged and output impedance remains sufficiently low. This design maintains the simplicity of the one active stage, requiring only the addition of a resistor and a capacitor, yet provides sufficient attenuation slope.

The active section of this filter shown in Fig. 5 is designed to have a frequency characteristic such that when its response is combined with the response of a passive section, R_1 and C_1, the resultant frequency characteristic closely resembles that desired. In order to achieve this type of frequency response in the active section of the filter, the factor βK must be greater than for an active filter without a passive section. The ratio of resistors R_2 and R_3 of Fig. 5 determines the gain K of the amplifier. The ratio of R_4 to R_5 determines the magnitude of β. The product βK greatly controls the shape of the frequency curve. Proper choice of the two resistance ratios can provide an optimum overall frequency characteristic and zero overall d-c insertion loss. Figure 6 shows the nominal overall frequency characteristic of the cascaded active and passive filter. This final design of the filter has a corner frequency of not less than one cps (3 db point); insertion loss, adjustable to zero if desired, less than one db with no adjustment; flat passband, within ±1 db from d-c to 0.7 cps; attenuation slope of 15 db per octave; input signal voltage range of 1.5 to +7.5 v peak; zero drift of less than 0.4 millivolt per degree C; d-c input impedance of 0.5 megohm; and an output impedance of 2.5 kilohms.

The filter is packaged in a modular plug-in subassembly. Silicon transistors are used because of their superior temperature characteristics. Supply voltages are regulated to minimize zero drift.

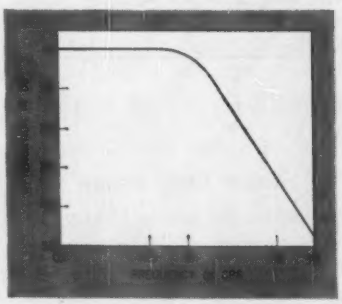

FIG. 6—Nominal overall frequency characteristic of filter-amplifier

In order to maintain the same degree of flatness in the pass band, a closer tolerance on capacitance is required for a cascaded active and passive filter than for a filter consisting of only active stages since a fall off in the pass band of the passive filter stage must be compensated by a corresponding peaking in the active stage to produce a maximally flat response. For this condition a given change in the capacitance of C_1 in Fig. 4 results in a greater change in the amplitude of the overshoot than when the frequency characteristic of the active stage is flat in the pass band. Using capacitors with a tolerance of ±20 percent, it was found impractical to combine the active filter stage with a passive stage of more than one section, and still maintain a flatness of ±1 db as necessitated by design requirements unless an additional adjustable resistance network were inserted in the feedback loop of the filter to vary β. The frequency characteristics of the filter might be maintained precisely within the limits imposed by the temperature coefficient of the capacitors by trimming the filter networks to keep constant the RC products of each section. In assembling the filter the capacitors can be measured and values of resistance selected to provide the required RC product.

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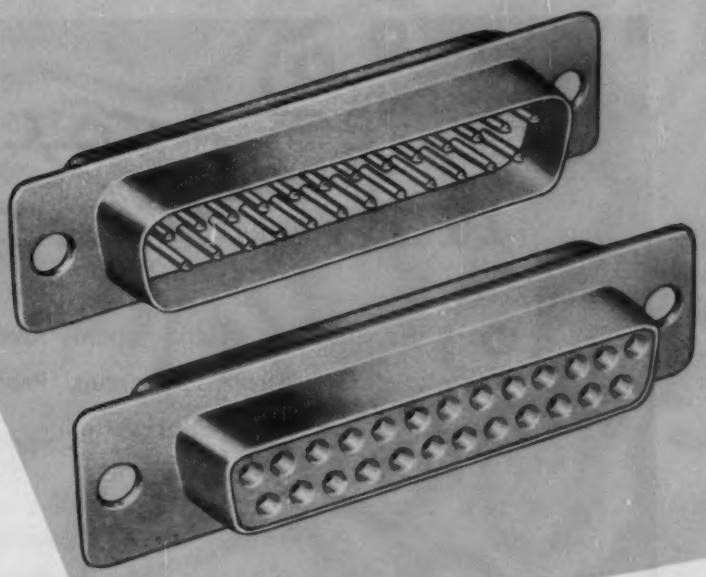

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PHYSICAL SPECIFICATIONS

SHELL MATERIAL INCLUDING FLANGE—D- steel or brass, finish, cadmium plate & irridite. DH- steel, finish, electro-tin over cadmium.

CONTACT MATERIAL—D- copper base alloy gold plate finish, DH- steel, electro-tin over cadmium finish.

INSERT ARRANGEMENTS—5 (plus coaxials)

NUMBER OF CONTACTS—9, 15, 25, 37, 50

INSULATION MATERIAL—D- Zytel 101, DH- Glass, C7- Diall (Type MDG Mil. M-14), C13- Melamine (Type MME Mil. M-14), C26- Glass Diall (Type GDI-30 Mil. M-19833), F114- Diall solder pot side, Nylon pin engaging side.

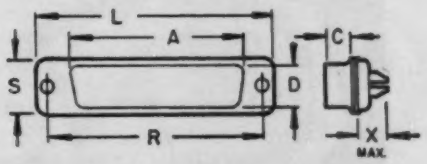
POLARIZATION—keystone cornered shell

COUPLING MEANS—friction-locking accessory

WIRE ACCOMMODATION—#20 AWG, B&S stranded

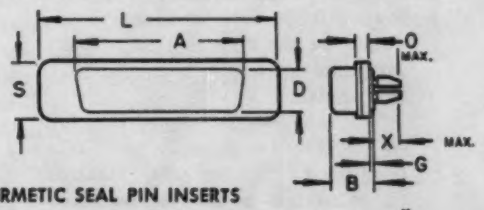
OPERATING TEMPERATURE—D + 310°F, —67°F, DH + 350°F max. —67°F, varies with finish: TIN PLATE — 350° max. CAD. PLATE — 500°F max., TIN over CAD. — 350°F max. GOLD PLATE — 600°F max.

D SUB-MINIATURES:
STANDARD PIN AND SOCKET INSERTS.



size	A	C	D	L	R	S	X	weight
DA-15P	1 1/64	15/64	23/64	1 17/32	1.312	31/64	5/16	.013
DA-15S	31/32	15/64	5/16	1 17/32	1.312	31/64	5/16	.014
DB-25P	1 7/16	15/64	23/64	2 3/64	1.852	31/64	5/16	.023
DB-25S	1 33/64	15/64	5/16	2 3/64	1.852	31/64	5/16	.031
DC-37P	2 11/64	15/64	23/64	2 23/32	2.500	31/64	5/16	.035
DC-37S	2 11/64	15/64	5/16	2 23/32	2.500	31/64	5/16	.035
DD-50P	2 3/64	15/64	15/32	2 5/8	2.406	39/64	5/16	.035
DD-50S	2 3/64	15/64	27/64	2 5/8	2.406	39/64	5/16	.040
DE-9P	43/64	15/64	23/64	1 13/64	.984	31/64	5/16	.011
DE-9S	41/64	15/64	5/16	1 13/64	.984	31/64	5/16	.012

FRACTIONS ±1/64 Tolerance DECIMALS ±0.005 Tolerance



HERMETIC SEAL PIN INSERTS

size	A	B	O	D	G	L	S	X max.	weight
DAH-15P-001	1 1/64	23/64	3/32	23/64	1/32	1 35/64	1/2	5/32	0.021
DAH-15P-002	1 1/64	23/64	3/32	23/64	1/32	1 35/64	1/2	15/64	0.021
DBH-25P-001	1 9/16	23/64	3/32	23/64	1/32	2 3/32	1/2	5/32	0.027
DBH-25P-002	1 9/16	23/64	3/32	23/64	1/32	2 3/32	1/2	15/64	0.027
DCH-37P-001	2 13/64	23/64	3/32	23/64	1/32	2 47/64	1/2	5/32	0.037
DCH-37P-002	2 13/64	23/64	3/32	23/64	1/32	2 47/64	1/2	15/64	0.037
DDH-50P-001	2 7/64	23/64	3/32	15/32	1/32	2 41/64	39/64	5/32	0.041
DDH-50P-002	2 7/64	23/64	3/32	15/32	1/32	2 41/64	39/64	15/64	0.041

Variation in final dash number indicates type of contact terminal. —001 = eyelet type; —002 = solder pot type.

FRACTIONS ±1/64 Tolerance DECIMALS ±0.005 Tolerance

CIRCLE 91 ON READER SERVICE CARD

Sweep Generator Design: How To Keep It Simple

Thoughtful selection of components takes care of both high and low temperature operation of four-transistor circuit. Precision multiple-range sweep generator is used in an airborne radar system

By **H. P. BROCKMAN***, Air Arm Division, Westinghouse Electric Corp., Baltimore, Md.

THIS SIMPLE multiple-range sweep generator, designed for use in an airborne radar system, contains only four active elements and provides a constant amplitude output sawtooth for all ranges, plus a fast rising gate-pulse (or pedestal) equal to the duration of the sawtooth.

How It Works

The circuit diagram, Fig. 1, consists of a conventional flip-flop, Q_1 and Q_2; a transistor switch, Q_3; an *R-C* timing network; an emitter follower, Q_4; and a diode feedback circuit composed of R_6, R_9 and D_1. Initially, Q_1 is cut off and Q_2 is in saturation, so that switch Q_3 is held in saturation by base current supplied through R_5. A positive trigger on the base of Q_1 drives Q_1 to saturation and opens switch Q_3. At this time, the potential on the collector of Q_3 rises exponentially from zero toward +300 volts at a rate determined by the time constant R_7 C_6, assuming switch S_1 is in the position shown.

The sawtooth is coupled through emitter follower Q_4 and a portion is fed back to the base of Q_2 through D_1, so that at some predetermined bias-level the flip-flop is reset with Q_2 in saturation and Q_1 cut-off. Switch Q_3 is driven quickly into saturation by a positive pulse through C_4 to the base of Q_3, thereby providing fast recovery for timing capacitor C_6.

Range switch S_1 provides a range sweep of 15, 50, and 200 miles by selecting a single timing capacitor for each range. The output sawtooth is obtained from the emitter of Q_4; a positive gate-pulse is obtained from the collector of Q_3. Precision timing of the sawtooth is obtained without adjustments by using precision parts in the *R-C* timing network and by making the input impedance to emitter follower Q_4 high compared to the value of R_7, so that the timing of the waveform is independent of the active elements of the circuit. The linearity of the sawtooth is held within one percent without the use of a bootstrap circuit by using a +300-v supply for the charging potential and by restricting the amplitude of the sawtooth to about 15 v.

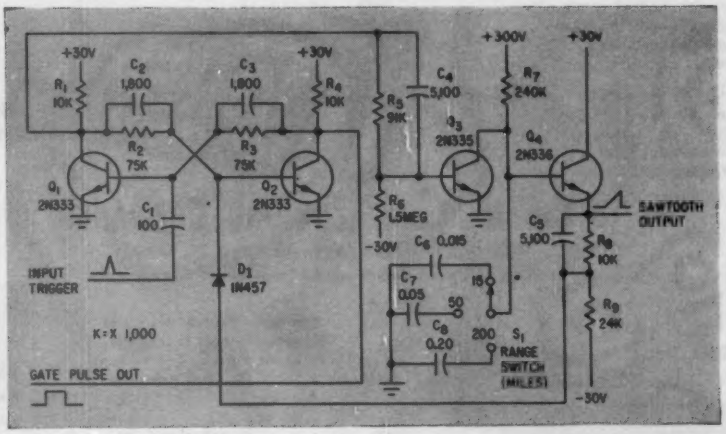


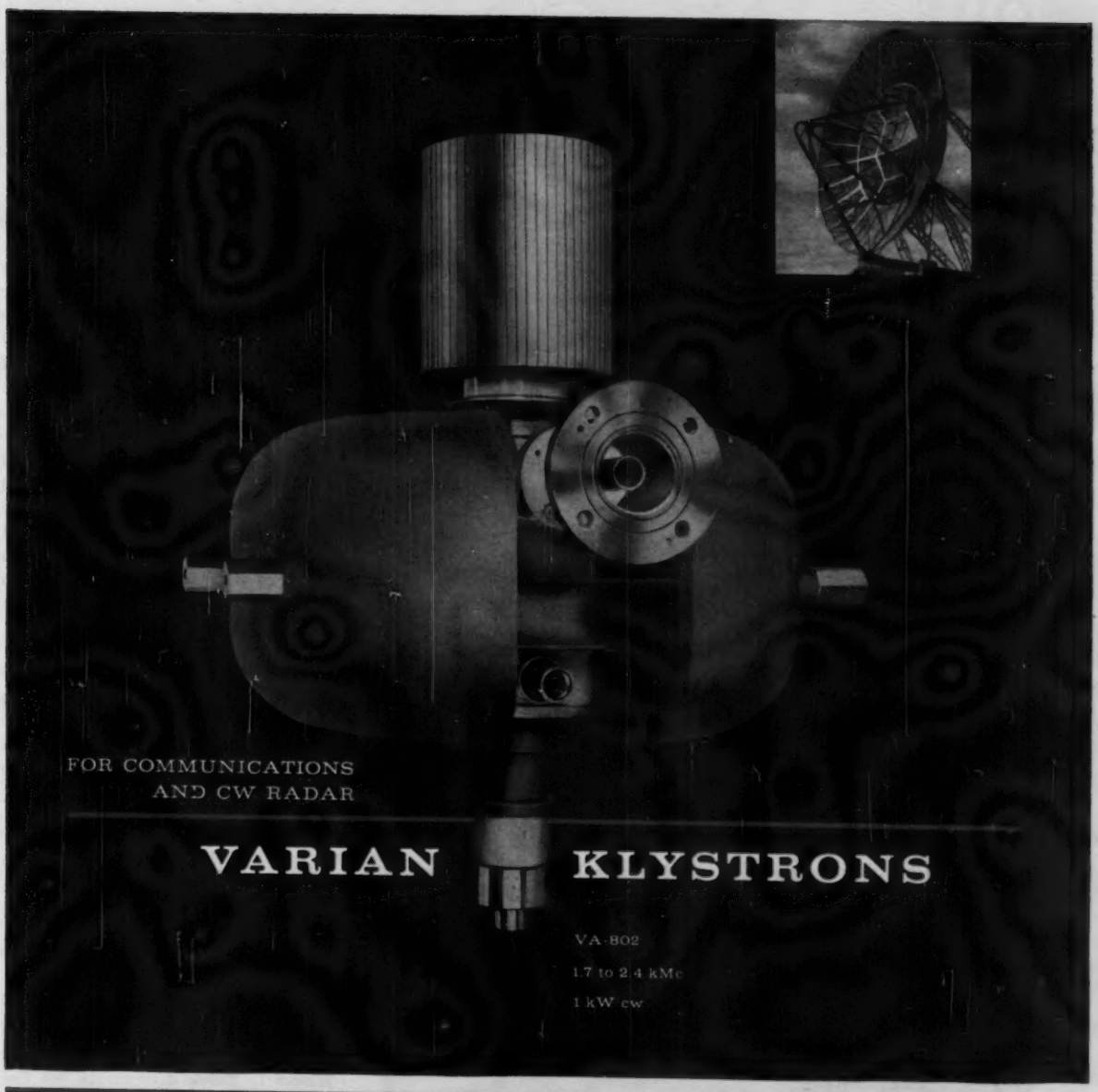
FIG. 1—Simple circuit provides constant amplitude for three ranges. Linearity is kept within one percent without use of a bootstrap circuit

Constant Amplitude

The amplitude of the sawtooth is determined by the bias level at the junction of R_8 and R_9 and by the energy required to trigger Q_3. Constant amplitude regardless of range selection is maintained by choosing the proper value of C_5. The trigger amplitude required for a slow rising sawtooth is less than for a fast rising sawtooth because the time duration, and thus the energy, of the former is greater. The value of C_5 is such that the feedback is increased for a fast rising sawtooth but it has very little affect on the feedback of a slow rising sawtooth.

The circuit is designed to operate over a temperature range of −55 to +85 degrees C. This required care in component selection.

* Now a member of the Electronic Development and Design Group, Missile and Surface Radar Division, Defense Electronic Products, Radio Corporation of America, Moorestown, N. J.



FOR COMMUNICATIONS
AND CW RADAR

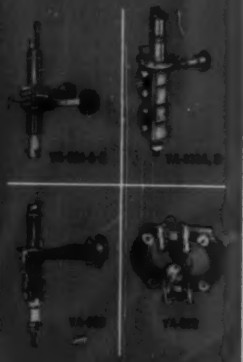
VARIAN KLYSTRONS

VA-802
1.7 to 2.4 kMc
1 kW cw

WIDE TUNING RANGE • AIR COOLED

The highly efficient VA-802 has been designed to meet the rigid demands of both fixed station installations and transportable service. Simple to install and operate, it provides rugged reliability at low operating cost—with power output of 1 Kw, tuning range of 1.7 to 2.4 kMc. Features of this 18" Klystron with permanent magnet include: Trouble-free internal cavities, low noise and long life.

Varian makes a wide variety of Klystrons and Wave Tubes for use in Radar, Communications, Test and Instrumentation, and for Severe Environmental Service Applications. Over 100 are described and pictured in our new catalog. Write for your copy—address, Tube Division.



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PALO ALTO 5, CALIFORNIA
Representatives throughout the world

VA-800	9.3 to 9.4 kMc	10kW pk
VA-802	1.7 to 2.4 kMc	1kW cw
VA-804	4.4 to 5.875 kMc	25W cw
VA-805	5.875 to 6.425 kMc	25W cw
VA-806	7.125 to 8.5 kMc	25W cw
VA-822	9.5 to 10.5 kMc	1kW cw
VA-833A, B	27 to 29.9 kMc	10kW cw

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, HIGH VACUUM PUMPS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, R.F. SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

CIRCLE 93 ON READER SERVICE CARD 93

800-Lb Film to Record Cosmic Rays

COSMIC RAY research program will be executed by the University of Chicago and the U. S. Navy. The program has entered the final months of preparation. The expedition to the West Indies area is called Skyhook 60 and is sponsored by the National Science Foundation and the Office of Naval Research. (See ELECTRONICS, p 11, Jan. 1, 1960.)

Objective of the experiment is to keep a large amount of film at the edge of the atmosphere in Skyhook balloons for as long as possible. The film will record cosmic rays at very high energy levels.

D. M. Haskin, Chicago University research aide to M. Schein, director of the project, will pick up 2,800 pounds of special film in England. The $100,000 worth of film will be flown back to Chicago to be put in capsules.

Balloon Capsules

The Atlantic fleet will aid in recovery of the 2,500-pound capsules to be released by the balloons. The balloons are expected to reach an altitude of 100,000 to 120,000 ft (18 to 22 miles) and to remain aloft for about 48 hours.

The balloons will be launched from the flight deck of the USS Valley Forge. Each balloon capsule will contain an 800-pound block of emulsion sheets somewhat like photographic film.

Emulsion Blocks

The emulsion blocks are designed to record primary cosmic rays or nuclear particles that reach energies as high as 10^{15} electron volts as they fall toward earth. Chicago University officials say that research at these high energy levels has heretofore been almost nonexistent.

The complete scientific program is named Project ICEF (International Cooperative Emulsion Flight) with 25 universities and research institutes taking part. All scientific work is under Schein's direction. He has been working in the area of cosmic ray research for several years using high altitude balloons. Funds totaling $625,000, were provided by the National Science Foundation to support the effort.

Haskin explained that at very high energy, cosmic rays penetrate the photographic emulsions at high altitudes, colliding with nuclei of the emulsion to cause showers of other fast particles. The collisions produce a series of nuclear interactions recorded in the photographic blocks. From the returned plates, the physicists hope to learn details of physical laws ranging from the nature and behavior of the smallest elementary particles to creation of cosmic radiation on a galactic scale.

Possible Results

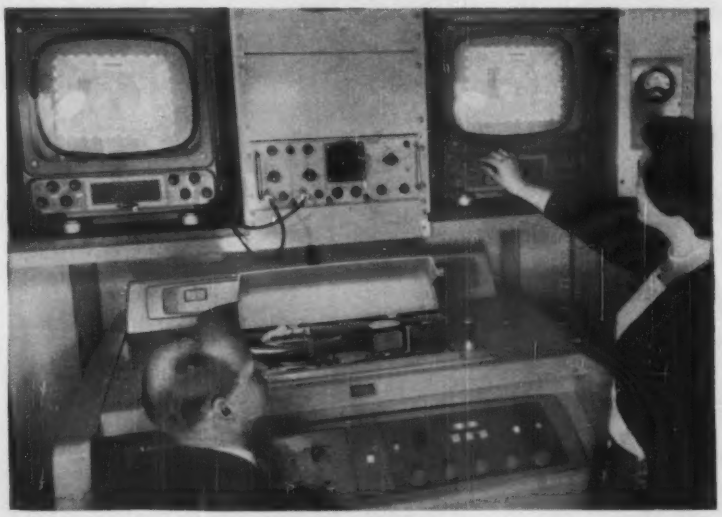
Present theories explain interactions of nuclear particles at low energy levels. However, there is no complete explanation of particle activity at very high energies, more than 100 times that of the 25^{15} electron volts produced by the Cern accelerator at Geneva. Formation of a more complete relativistic theory of very high energy phenomena may result from the cosmic research project.

The unusually large block of emulsion sent to high altitudes for long periods increases the number of high energy primary particles detected. Nuclear events can be traced in three dimensions by the stacked sheets. Depth of the emulsion block allows detection of many complete events, such as the entire chain of secondary interactions that were started by each primary particle.

High altitude is a prerequisite because primary particles will be captured before they have collided with particles in the atmosphere and become secondary particles of lower energy. Earth satellites could not be used because they would pass through the Van Allen radiation belts, fogging the emulsion.

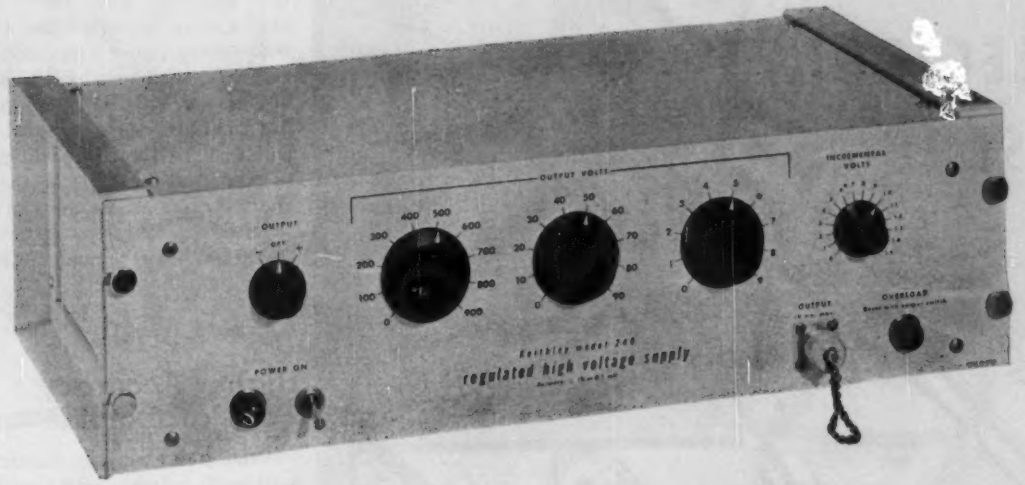
Area of the balloon launch was chosen for its proximity to the Equator, where the magnetic field is strongest. This field provides a

Mobile Tv Recorder Uses UK/European Standards



Television recording system by Ampex is housed in specially sprung vehicle. Unit can be modified for American, Continental or 405-line British tv standards.

dial any output from 0-1000V within 1%



KEITHLEY Model 240 High-voltage Supply combines convenience, accuracy, wide range

This convenient supply brings new speed, ease and accuracy to laboratory tests. Typical applications include calibration of meters and dc amplifiers, supplying potentials for photomultiplier tubes and ionization chambers. Other uses include furnishing potentials for high resistance measurements, and for diode and capacitor leakage resistance tests.

The Model 240 output delivers 0 to 1000 volts at up to 10 milliamperes. Three calibrated dials on the front panel select the desired output voltage in one volt steps, with accuracy of 1% or 100 millivolts. Greater accuracy may be obtained with a potentiometer provided for setting the output with an accurate voltmeter.

Polarity is selectable. The switch includes an "OFF" position, facilitating timed measurements. An overload relay cuts off the output at 12 milliamperes within 50 milliseconds. Connectors are provided on front and rear panels.

SPECIFICATIONS

DC OUTPUT VOLTAGE: Positive or negative, 0 to 1000 volts, in one volt steps.

OUTPUT CURRENT: 0 to 10 milliamperes.

ACCURACY: Within 1% above 10 volts, within 100 millivolts below 10 volts.

LOAD REGULATION: 0.02% for 0 to 10 ma.

RIPPLE: Less than 3 mv RMS above 5 cps.

OUTPUT IMPEDANCE: Less than 15 ohms.

STABILITY: After a 20-minute warmup, within 0.02 volts $\pm$ 0.02% the first hour, or in any subsequent 8-hour period, with line voltage changes within $\pm$ 10%.

LINE REGULATION: Output change is less than 0.02 volts + 0.02% for a 10% change in line voltage.

RACK mounting, shown above with accessory end frames, bench mounting.

PRICE $325.00

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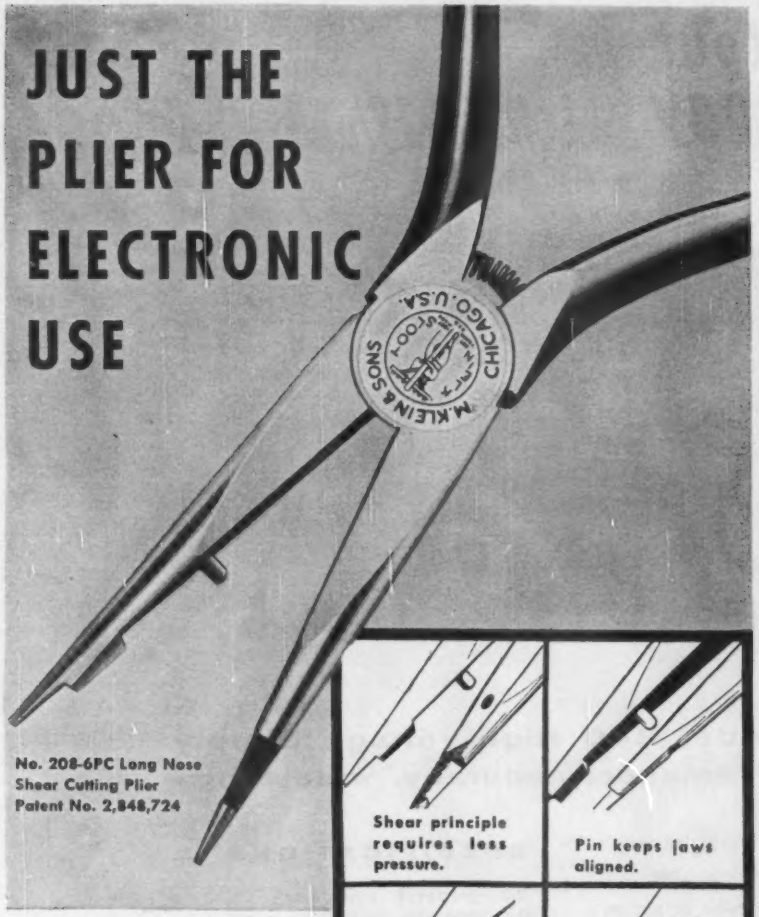
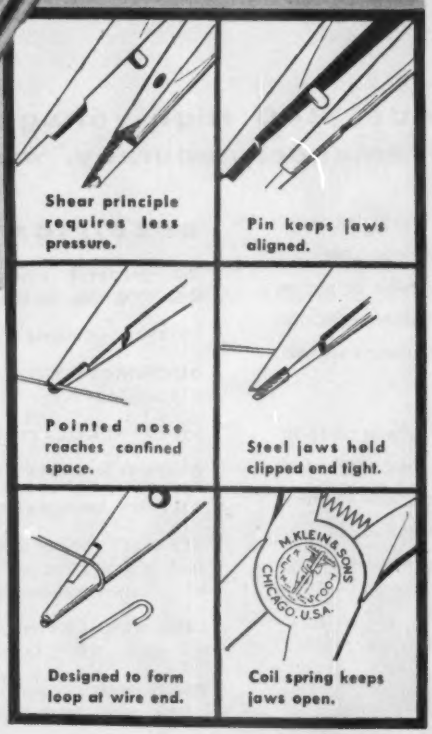
KEITHLEY INSTRUMENTS, INC.
12415 EUCLID AVENUE • CLEVELAND 6, OHIO

JUST THE PLIER FOR ELECTRONIC USE



No. 208-6PC Long Nose Shear Cutting Plier
Patent No. 2,848,724


Shear principle requires less pressure.
Pin keeps jaws aligned.
Pointed nose reaches confined space.
Steel jaws hold clipped end tight.
Designed to form loop at wire end.
Coil spring keeps jaws open.
M. KLEIN & SONS
CHICAGO, U.S.A.

Here is a recently developed plier specially designed for electronic use. It will fit into confined space and the steel jaws hold clipped end of sheared wire firmly . . . nothing to wear out.

The shear blade is at an angle of 15 degrees (the standard angle of regular diagonal pliers). Shear principle assures smooth, continuous action without snap, preventing shock which might damage transistors and other delicate components. For use with bare wire up to 18 gauge.

See your electronic supply house or write for catalog.

WRITE FOR CATALOG 130-A
Klein Catalog 130-A describing the 208-6PC and many other Klein Pliers, will be sent on request. Write for a copy.

Foreign Distributor: International Standard Electric Corp., New York

Mathias KLEIN & Sons
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barrier to low-energy cosmic rays up to about 10^{12} electron volts, effectively filtering out these low-energy rays.

Winzen Research, Inc., developed the balloons, and the emulsion blocks were manufactured in England by the Ilford Company. After recovery, the blocks will be shipped to Chicago University for processing for a two-month period. They will then be sorted and dispatched to cosmic ray groups in the U. S. and overseas. Chicago University scientists say these groups will take about two years to analyze the data completely.

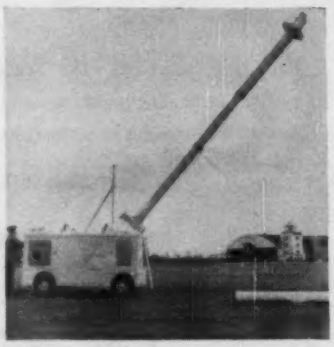
Higher Accuracy For Paraboloids

DEVELOPMENT work on plastic parabolic radio mirrors may provide antenna surface accuracies presently not practical. The technique was announced by D. S. Kennedy & Co., Cohasset, Mass.

Spincasting

The parabolic reflectors are produced by a process called spincasting. It is based on a natural law hitherto little recognized and little used except in optics. The method is based on the fact that the surface of a liquid curves into the shape of a paraboloid when the

Antenna Tests Electronics of F-105



Trailer unit called RADFAC (Radiating Facility for Aircraft Flight-Line Testing) was developed by Republic Aviation. Antenna with self-contained power source permits 60-second checkout as far as two miles from jet

Now your present electronic counter becomes a really good, accurate **DIGITAL VOLTMETER** by simply adding this self-contained, inexpensive

dy 2210 Voltage-to-Frequency

CONVERTER

Now it is simplicity itself to read voltages in direct digital form using your present electronic counter and this new Dymec DY-2210 Converter. You can also measure the time integral of fluctuating voltages directly in volt-seconds — no more tedious, costly manual data reduction and analysis. Unique design principle of the DY-2210 makes it insensitive to most kinds of noise on the input signal.

The DY-2210 generates pulses at a rate accurately proportional to the dc input voltage. Zero input produces zero output cycles, 1 volt produces 10,000 cps. A front-panel attenuator provides additional input ranges of 10 v, 100 v and 1000 v. Positive or negative inputs sensed automatically. Models available for ac inputs and remote programming applications. Price: $660 cabinet, $650 rack-mount.

For details and demonstration, see your Dymec/Hewlett-Packard representative or write direct.

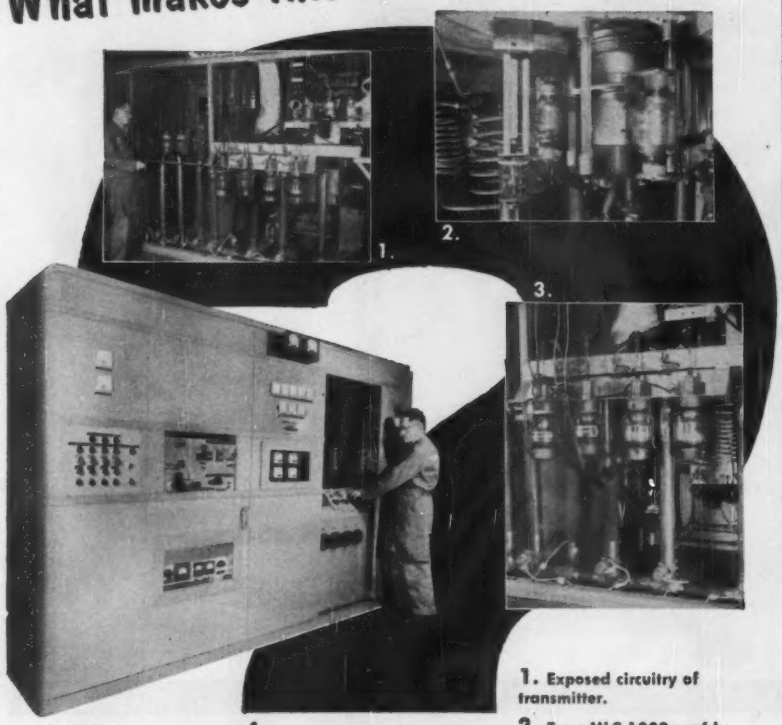
RACK MODEL, PANEL HEIGHT ONLY 3½"

DYMEC A DIVISION OF HEWLETT-PACKARD CO.

6063E PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A. DAvenport 6-1755

Dymec/dy field representatives in all principal areas

What makes this transmitter possible?

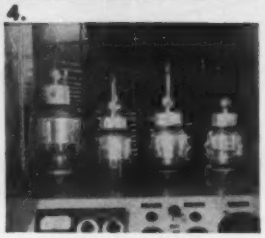


100 KW BANDSWITCHING TRANSMITTER ELIMINATES TUNED INDUCTANCES

1. Exposed circuitry of transmitter.

2. Type MLC 1000 mmfd. vacuum capacitors for plate blocking. Band switching is accomplished with Type R1 vacuum switches.

3. Type VMMHC vacuum capacitors in the plate tank circuit. Switching from each output tank to a common load is done with Type RC10 vacuum coaxial relays.



4. Vacuum capacitors in the output tuned circuit.

This 100 kw transmitter is used to test and establish ratings on Jennings high voltage vacuum components. The testing program may require rapid frequency changes to 2, 4, 8, 16 and 32 mc. Each band is tuned by motor driven vacuum capacitors. Single dial panel switching between bands is accomplished with vacuum relays.

Fixed inductances were desired in the tank circuit in order to avoid problems of maintenance and resetability associated with transmitters that use tap switches and sliding contacts. This was made possible by taking advantage of the low minimum capacitances, small size, and low inductance of vacuum variable capacitors. This circuitry would be particularly useful in any rf transmitter design demanding daily repetitive frequency changes.

Space reduction and efficiency were further improved by using Jennings vacuum relays with their high voltage and current carrying capabilities. The sealed contacts are clean and remain clean because they are free of all oxides and contaminants. In addition vacuum relays never need maintenance.

Write for our new vacuum component catalog summary. It may suggest the answer to some of your present high voltage problems

RELIABILITY MEANS VACUUM
VACUUM MEANS Jennings®

JENNINGS RADIO MANUFACTURING CORPORATION • 970 McLAUGHLIN AVE. P. O. BOX 1278 • SAN JOSE 8, CALIF.

containers in which the liquid is held is rotated about an axis at constant speed.

Advantage claimed for spincasting applied to antennas is that surface accuracies more than a thousand times greater are achieved than by most known methods. Except for machining, which is prohibitively expensive on large dishes, present tolerances are seldom better than ¼ inch.

The liquid used is one of the new synthetic resins. The liquid resin is put into the container at the beginning of the spin. The spinning table on which the container is fastened is rotated, and the liquid moves out to assume the characteristic shape. The liquid synthetic resin hardens into a cast within a few hours.

The pan that contains the plastic liquid is actually a conventional antenna reflector with its normal surface irregularities. The liquid resin coating the paraboloidal reflector surface imparts an almost glass-like smoothness to the surface if desired.

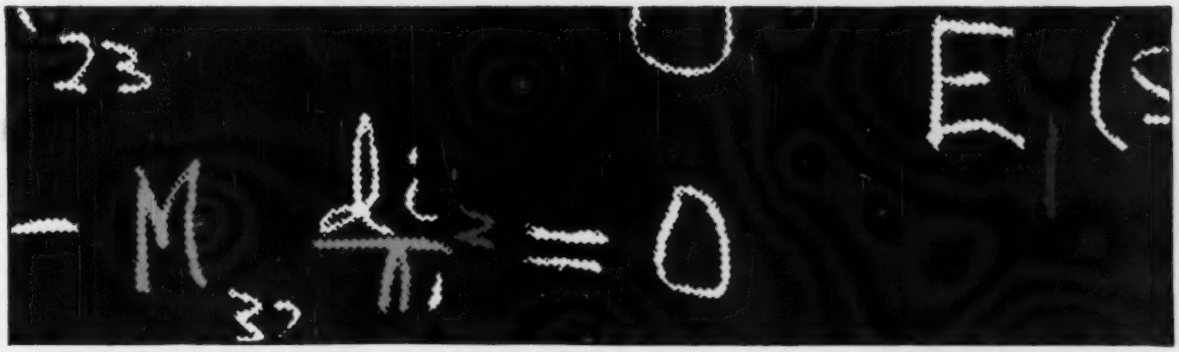
The surface is then metallized so that it acts as a radio frequency reflector.

Benefits

Expected benefits of the new process are greater efficiencies in r-f power transmission and reception at much higher frequencies than are now practical. Advances in satellite tracking, space communications and radio astronomy are expected as a result of the new development in producing accurate antenna surfaces.

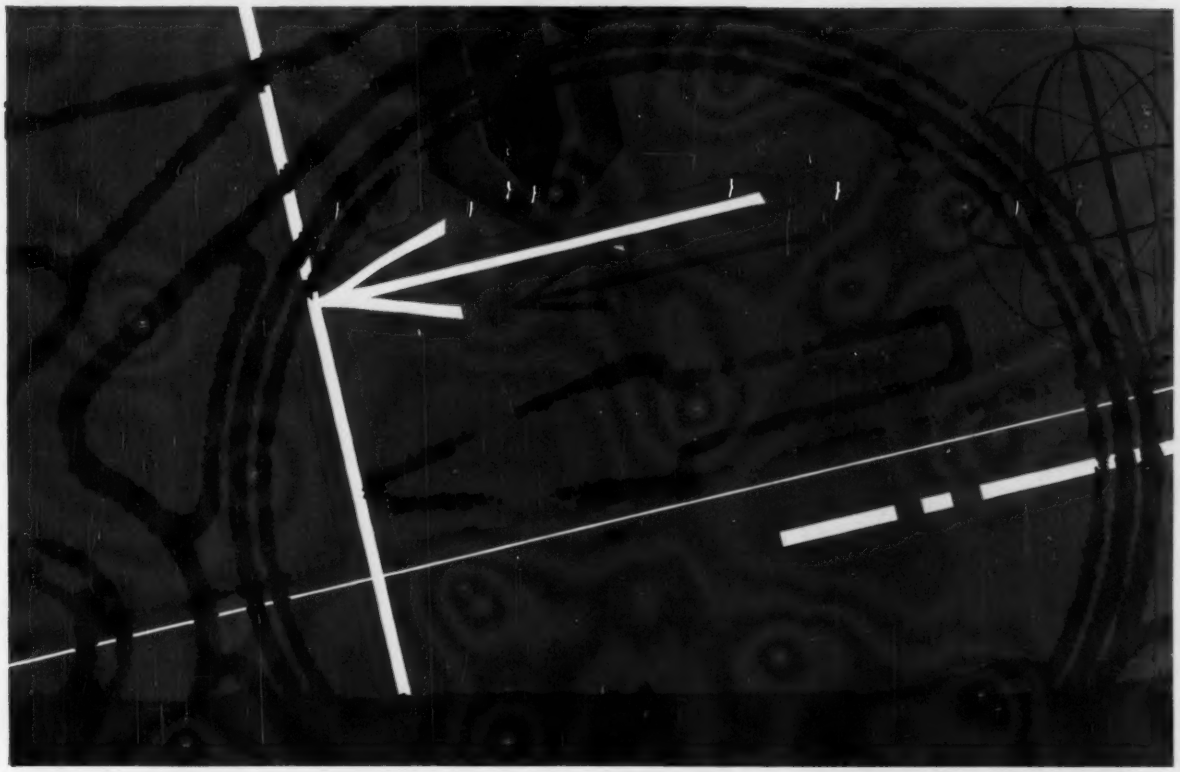
The company has developed a 4-ft pilot model and is working on a 10-ft design. Spincast antennas up to 60 ft in diameter are planned for early development. Theoretically there seems to be no size limit for this production method except for the size limitation of a stable spinning table.

Work on spun plastic optical mirrors has been done by P. B. Archibald of the University of California Radiation Laboratory under auspices of the Atomic Energy Commission. Optical paraboloids of this type up to 3 ft in diameter have been produced for the purpose of light gathering.



General Motors pledges

AC QUESTMANSHIP



AC Seeks and Solves the Significant—AC Design and Development is moving far ahead in new technology—the result of GM's commitment to make ever larger contributions to the defense establishment. AC plans to resolve problems even more advanced than AChiever inertial guidance for Titan / This is AC QUESTMANSHIP. It's a scientific quest for the development of significant new components and systems . . . to advance AC's many projects in guidance, navigation, control and detection / Dr. James H. Bell, AC's Director of Navigation and Guidance, sees this as a "creative challenge". His group takes new concepts and designs them into producible hardware having performance, reliability and long life. He strongly supports the fact that an AC future offers scientists and engineers "a great opportunity to progress with a successful and aggressive organization" / If you have a B.S., M.S., or Ph.D. in the electronics, scientific, electrical or mechanical fields, plus related experience, you may qualify for our specially selected staff. If you are a "Seeker and Solver", write the Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, Box 746, South Milwaukee, Wisconsin.

GUIDANCE / NAVIGATION / CONTROL / DETECTION / AC SPARK PLUG *The Electronics Division of General Motors*

Bending Ceramic and Ionic Crystals

By SHELDON WEINIG, President, Materials Research Corporation, Yonkers, New York

DESIGNATING a ceramic material as useful for a specific application severely limits its scope. Under the impetus of space and rocket requirements as well as cryogenic and elevated temperature needs, ceramic materials are now used in areas never before considered.

This article discusses four basic ceramic research programs and some very general areas of application. These programs are presently being performed at the laboratories of the Materials Research Corporation in Yonkers, New York, under contract to the Office of Naval Research, Atomic Energy Commission and the Office of Scientific Research, U. S. Air Force, respectively.

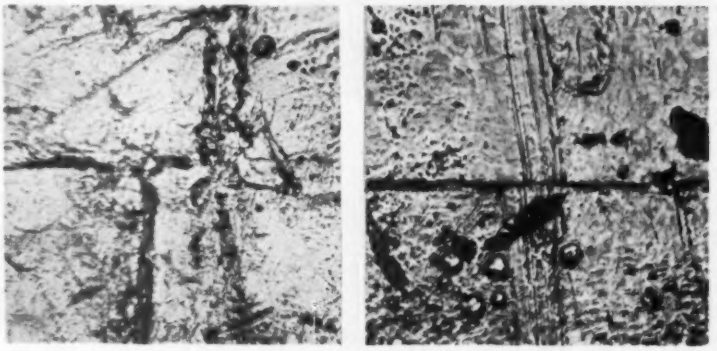


FIG. 2—Microphotographic studies exhibiting grain boundary displacements in ceramic crystals are being used to investigate thermal conductivity. Attempts are made to create thermal diffusion paths

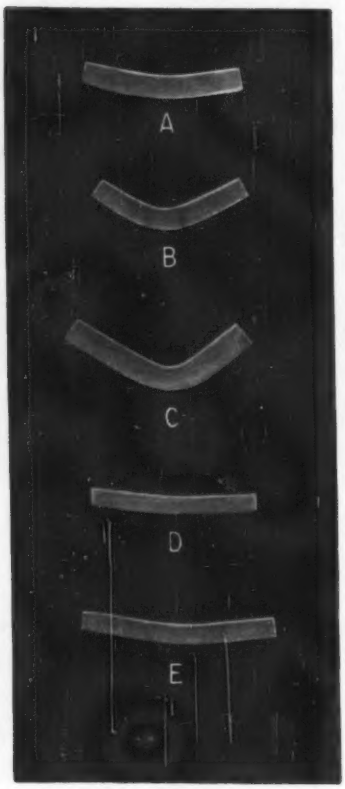


FIG. 1—Examples of crystals of ceramic and ionic materials. Ionics were bent by application of high d-c voltage. Ceramics were bent after a clean surface was produced. NaCl bent at —117 C (A) and at 25 C (B); LiF bent at 400 C (C); and MgO bent at 25 C (D) and 400 C (E). Electronic applications are apparent

Ductile or Brittle

Undoubtedly the most important physical property of a metal is its formability. In contrast, one serious difficulty in utilizing ceramic materials is their inability to be plastically deformed. It was recently found that a single crystal of magnesia (MgO) could be bent immediately after cleaving, that is after a clean surface was exposed. This led to the conjecture that the embrittled state was not the natural state of the material, but that ductility was lost because of surface contamination.

Using this concept it has been possible to bend "clean" crystals of ceramic and ionic materials as illustrated in Fig. 1. This apparent ductility is certainly of interest in the laboratory but lacks the adaptability required for practical application. What is required is a mode of ductilization that doesn't necessitate cleaving or dissolving the material immediately prior to deformation.

A technique has been developed which will ductilize ionic crystals through the application of a high voltage d-c source across the material during the actual deformation. Crystals of NaCl were bent into a horseshoe shape, reversed, and bent in the opposite direction. Although the technique has not been extended to MgO or other ceramic materials, applications for the ionics are immediately apparent: Crystal detectors requiring special shapes, or perhaps a more important application is for crystal transducers.

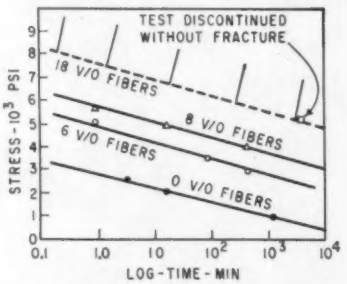


FIG. 3—Curves show stress rupture curves for aluminum with no reinforcement (O v/o fibers) and with varying concentrations of longitudinally-oriented ceramic fiber-alloy compacts (6, 8, and 18 v/o fibers)

Grain Boundary Phenomena

The poor thermal shock resistance of ceramics is due to the inability of the ceramic to equalize its heat content sufficiently rapidly, i.e. low thermal conductivity. If impurity atoms of a metallic nature were preferentially segregated to the grain boundaries then short

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temperature range — The Type D is designed to operate over the temperature range of −55°C to +125°C at rated working voltage without derating.

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insulation resistance — The insulation resistance of these capacitors will exceed 3,000 megohms at 125°C.

moisture resistance — Insulation resistance shall be greater than 1000 megohms as measured in accordance with paragraph 2.6.2 of EIA specification RS-186-A, Method 2. Paragraphs 2.4 and 2.6.1 do not apply. The test shall continue for 10 cycles, as described in paragraph 2.5.

thermal and immersion cycling — Insulation resistance shall be greater than 3000 megohms after being subjected to temperature cycling between −55°C and +125°C, as outlined in Method 102-A, Test Condition D, and followed by Method 104-A, Test Condition A, of MIL-STD 202A.

Write for Bulletin TSC-118C

TYPE	DC WORKING VOLTAGE - VOLTS.	CAPACITANCE RANGE - MMF.
D-15	500	5-400
	300	5-800
D-20	500	100-2000
	300	100-4000
D-30	500	1000-10000
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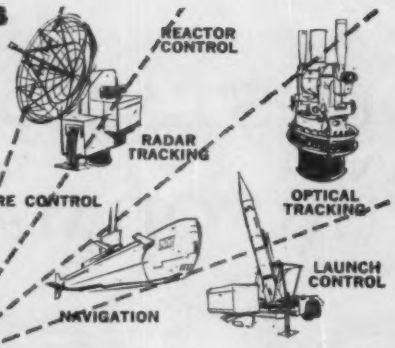

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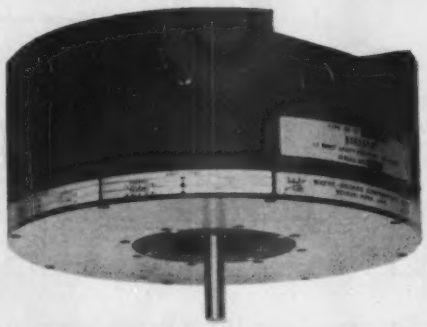

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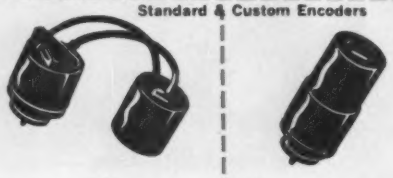
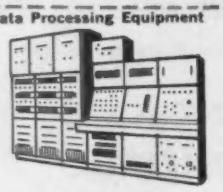


Data Processing Equipment



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circuit thermal diffusion paths could be developed which will result in a marked increase in thermal shock resistance.

One method of measuring the ability of an atom to segregate at the boundary is to measure the shear resistance of the grain boundary. This study is performed with bi-crystals of Mg0. The program also investigates the mechanism of elevated temperature deformation of the ceramic material.

Bi-crystals of NaC1 and Mg0 have been sheared under varying conditions of time, temperature and applied load. Typical specimens are shown in Fig. 2. The originally straight fiducial markings have been displaced across the boundary. Present experiments are designed to selectively segregate metallic impurities at the boundaries.

Ceramic-Metal Fibers

One of the most interesting areas of materials technology has been the attempt to combine different types of substances and thereby utilize the excellent properties of each: in particular, making composite metal-glass fiber and metal-ceramic fiber compacts. This concept is similar to reinforced concrete where the metal rods are replaced with glass or ceramic fibers and the metal substituted for the concrete.

In this way the inherent strength of the fibers due to both material and geometry is obtained while still retaining the excellent properties of the metal. The high surface-to-volume ratio of the fiber reduces the thermal shock propensity of the ceramic material.

Materials

Compacting is especially advantageous in that it is in no way restricted to any specific fiber or metal combination. Successful compacts have been made between materials that are not normally compatible by utilizing intermediary coating agents for the fibers.

Typical results are shown in Fig. 3. More dramatic results have been obtained with high melting point metals and ceramic fibers but can not be shown at this time.

As a corollary to the above work, a proprietory technique was de-

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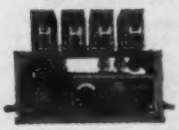
NM-30A (AN/URM-47)
20 mc to 400 mc

NM-50A
(AN/URM-17)
375 mc to 1000 mc



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veloped for metal coating ceramic fibers. This method has already found application in soldering leads to piezoelectric devices.

Fast Switching Diodes For Half Amp Pulses

VOLUME PRODUCTION of 0.3 μsec, ½ ampere devices that have a peak power dissipation of 800 milliwatts now make these very fast high-current silicon switching diodes readily available for computers.

The new diodes are said to approach a universal, all-purpose diode, excellent for general high-conduction applications as well as for the more exacting computer uses. Available in four voltages, these devices are designed for operation up to 175 C and feature high forward conductance (500 ma at one volt maximum drop) and low leakage (50 μamp max at 150 C).

The units feature a maximum recovery time of 0.3 microsecs to return to 10 k ohms when switched from a forward current 2 microsec pulse of 500 ma to a reverse voltage of −50 v, with a loop impedance of 1 k ohm. Faster switching speeds are obtained at lower currents.

These devices have been used in the Univac Lark computer, Remington Rand, which operates at very high speeds and in more than a dozen other high-speed computer prototypes.

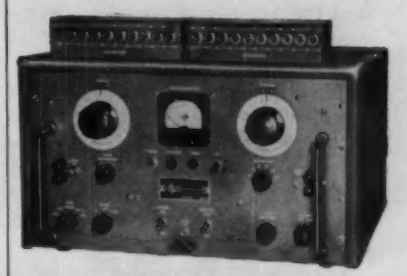
The diodes are now in production at Sperry Semiconductor Division of Sperry Rand Corp., South Norwalk, Conn., and will be used for computer switching, pulse clamping, gating, blocking and diode logic circuits.

Spray-On Insulator

A NEW COMPOUND, sprayed like paint, dissipates heat and controls temperature by a process similar to the vaporizing of dry ice directly from solid to gas without passing through a liquid stage.

Called Thermo-lag, and developed by Emerson Electric Manufacturing Co., St. Louis, Mo., the material has been sprayed on the outside of space capsules. Protection afforded is well within ranges for performance of internal electronics.

As basic to construction as nuts and bolts, the fast pulse generator is a mainstay in all phases of pulse circuitry design and development.
Crosby-Teletronics' Model PG-200AA is a wide range, precision instrument which generates adjustable rectangular waveforms with fast rise and decay times. Accurately calibrated wide ranges of pulse duration, amplitude, recurrence rate and positioning are provided. The unit may be driven by an external signal of almost any waveform or may be operated self-synchronous. Either way, it furnishes a fast trigger to synchronize auxiliary equipment.



Model PG-200AA
Fast-Pulse Generator—$850.

Model PGA-210
Range Extender —$80.

The PG-200AA provides calibrated pulse position and duration ranges of 0.1 to 50 microseconds. With Range Extenders (Model PGA-210), both may be increased to 1000 microseconds. Write for operating data and specifications material.

Crosby–Teletronics Corporation
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Lead wires are positioned with tubular jig

Jewelers' lathes and eyepieces are required for production and inspection of miniature slip rings. Box at right is tote fixture

Encapsulate First—Machine Later

NORMAL ASSEMBLY procedures are reversed in the production of miniature slip rings by Electro Tec Corp., S. Hackensack, N. J. Encapsulation is one of the first steps, machining and metal deposition follow.

Among production advantages cited by the firm are: fixturing is simplified, lead-to-ring connections are strain free, better dimensional control promotes miniaturization, and the number of rings can be increased without a corresponding increase in production costs.

Ring styles vary widely. Cross sections of a typical miniature type is shown in Fig. 1. This type has a body molded over the bundled leads. The body is machined and the rings formed in the machined grooves.

Leads are first bundled around a notched and varnished center wire. The ends of the center wire are clipped off at the notches (scores) as a finishing operation. Lead wires are prepared by winding wire on a cam whose circumference equals the length desired. The coil is slit into individual leads.

Leads are held in position with soft wire wrap

Bundle is primed with encapsulating compound

Body slug is formed around leads by molding

Dental drill is used to cut ring keys in shaft

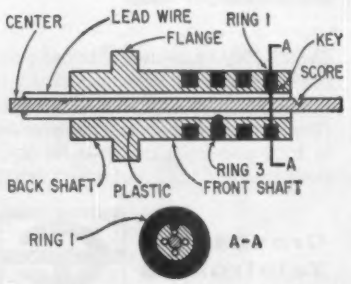

FIG. 1—Cross sections of typical miniature cylindrical slip ring assembly

Bundling Leads

The wires are aligned in parallel holes running lengthwise in a cylindrical jig. The holes correspond to wire positions in the body. The jig is slid up the wires while being rotated, forming a twisted bundle. Outer ends of the bundle are later soldered to maintain position. Ends which will be inside the body are laid parallel on the center wire by withdrawing the jig in a straight motion. As the inner ends are exposed, they are wrapped with soft nickel-plated copper wire turns spaced about ☆ inch.

The wrapped ends are dipped in an encapsulating primer of epoxy or polyester resin, depending on the body material. After the primer is dried, securing the bundle, the wrapping wire is removed. Collars are placed on the bundles and the

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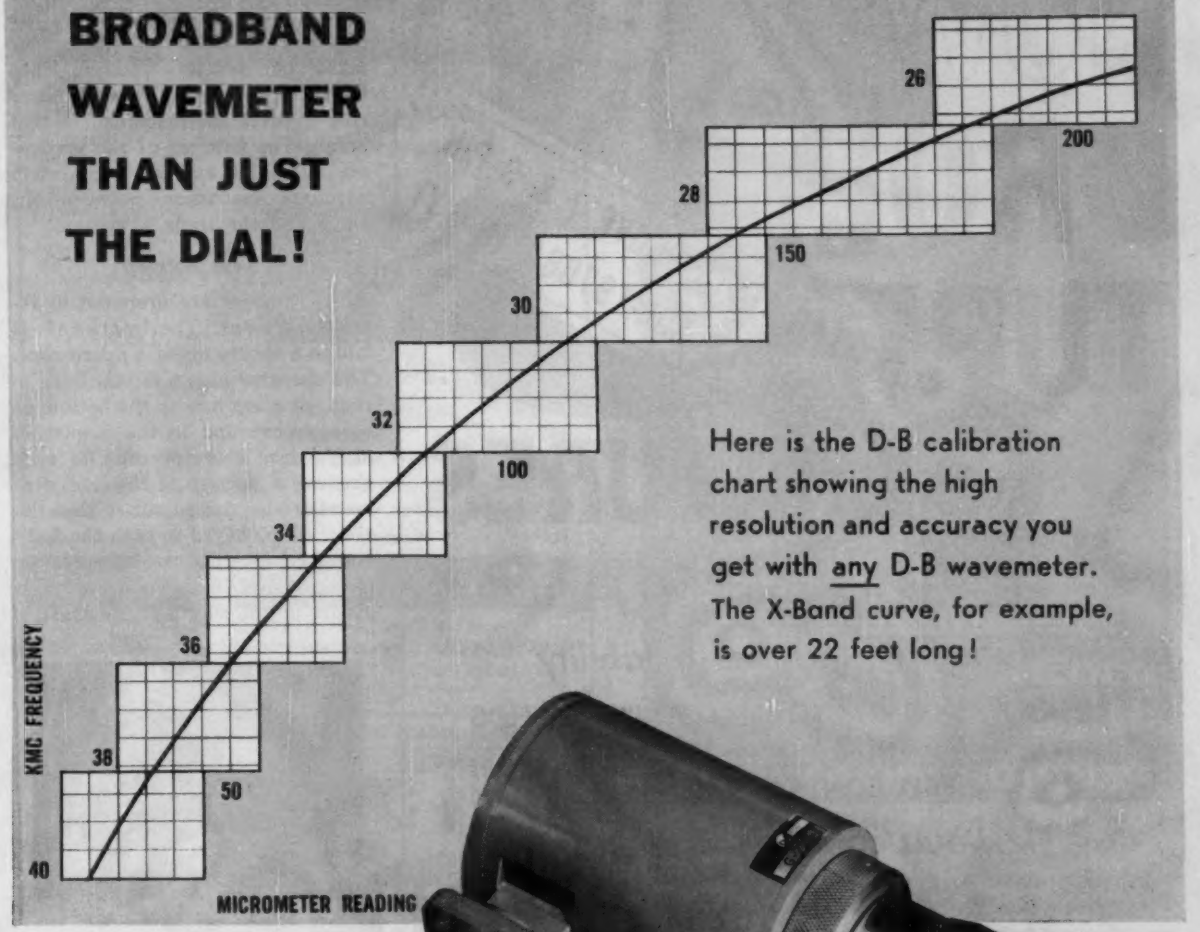

Here is the D-B calibration chart showing the high resolution and accuracy you get with any D-B wavemeter. The X-Band curve, for example, is over 22 feet long!

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47 PROSPECT STREET, WOBURN, MASSACHUSETTS

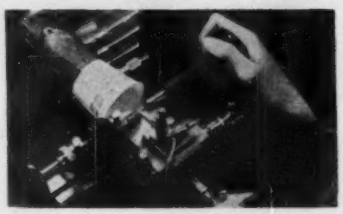
bundles are encapsulated in 20-cavity molds. This forms a slug of plastic around the bundle.

After curing, the slug is removed from the mold and machined into the body. Four series of cuts are made on jewelers' lathes. The flange, front shaft, backshaft and ring grooves are machined in that order. The bottoms of the grooves are left thick enough to maintain adequate insulation between the rings and the leads.

Keys Formed

The grooves are prepared to receive the rings. The front shaft is laid in a fixture under a microscope. The operator uses a dental burr to rout out a key hole in the bottom of each groove and in the insulation of the lead corresponding to each groove. A portion of the lead wire metal is also routed out so that the ring will be keyed to both the body and the lead. The routed spots, or picks, form a spiral from groove to groove up the length of the shaft.

Groove bottoms are painted with conductive paint



Cup catches gold dust during finish machining

Bottoms of the grooves are coated with conductive paint, generally a fine silver or gold suspension. The painter applies the tip of a small brush to the groove bottom as the body rotates in a lathe. A pick is then used to reexpose the lead wire metal and to remove any paint on the groove walls.

Rings are deposited as previously reported (ELECTRONICS, p 128, Dec.

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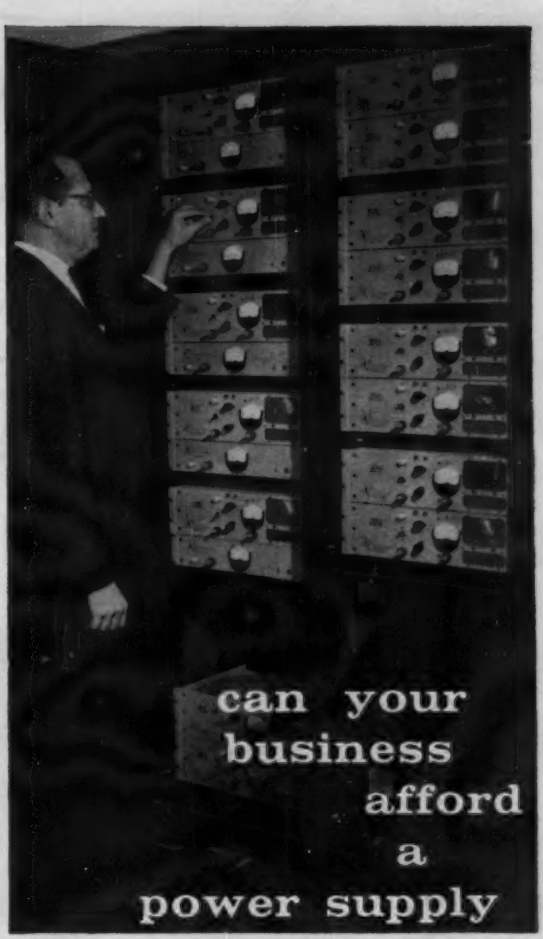

failure?

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The power supplies shown in the photograph are Model PS-4000B . . . typical of the broad industrial line of POWER SOURCES precision, transistor regulated supplies. Other supplies available range in output from 4.5 volts at 10 amps to 300 volts at 1.5 amps. Each is "short-circuit protected" and designed to provide a highly regulated source of power for critical Industrial or Military applications. Write for complete specifications.

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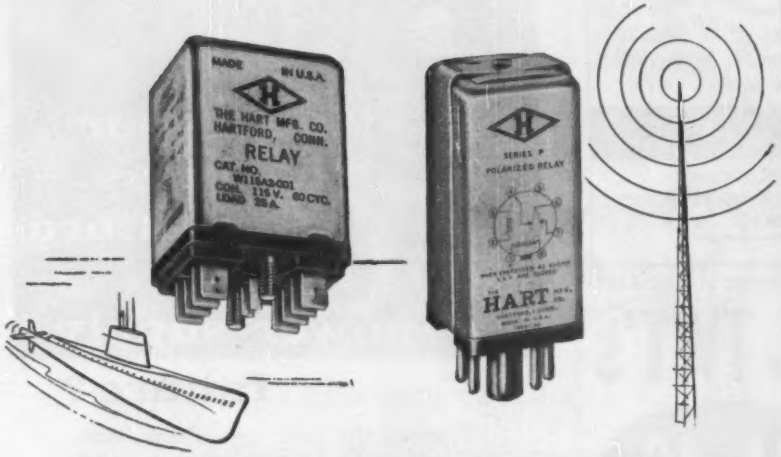


"DIAMOND H" Relays

Look into the heart of the control system for a missile, a computer, a nuclear submarine, or a great many other critical applications. You might be surprised how often you'll find "Diamond H" relays.

Unless, of course, you're one of the increasing number of engineers who've already selected "Diamond H" relays for a spot where they just have to work despite all sorts of adverse conditions.

Hart makes relays of three basic types: miniature, hermetically sealed, aircraft-missile relays (Series R/S); high speed, sensitive, polarized relays (Series P), and general purpose AC, DC relays (Series W).

Technical literature outlining the wide range of characteristics available with each type relay is yours for the asking. You'll find "Diamond H" engineers uncommonly adept at working out a variation of the basic designs to meet your set of specific requirements.

Tell us your needs . . . by phone, wire or letter.

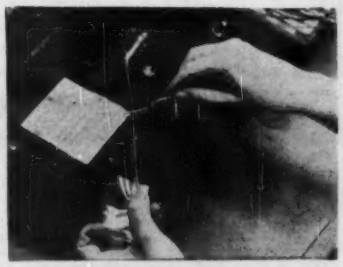
THE **HART** MANUFACTURING COMPANY

202 Bartholomew Ave., Hartford 1, Conn.

4, 1959). The deposit is allowed to build up over the top of the grooves. Overdeposition permits the rings to be machined and polished back to final size with a more regular surface.

Finishing Steps

Center wires are removed at the scores and ground flush with shaft ends. Finish machining is done with a diamond tool on a jewelers' lathe. Vacuum pipes at the tool recapture gold or silver chips and dust. Very light cuts are taken. The ring surface is buffed with rouge to a finish of 2 microinches. Higher finishes can be obtained with diamond tools, but buffing assures surface regularity. After buffing, the assembly is ultrasonically cleaned to removed rouge. Silver rings may be given a finish plating of buffable gold.



Bodies are handled with plastic bags during insulation test

Radiating leads are placed in clips to test lead-ring continuity

Other finishing operations include clipping off the soldered ends of the lead bundle, visual and electrical inspection, and packaging. Inspections are also made after each production step and by roving inspectors. After final buffing or plating, the cleaned assemblies are handled by the wire bundle. Shafts are put in small plastic bags, which are also used as holders. Production is scheduled in batches, since many of the rings are custom-built.

VALUABLE 64 PAGE REFERENCE SECTION

in electronics BUYERS' GUIDE

Prepared especially by the 25-man editorial staff of *electronics*, this 64-page section is designed to assist the buyer by providing him with market data, electronics applications, market distribution, market reports and books, industry organizations and services.

electronics BUYERS' GUIDE
and Reference Issue

A McGraw-Hill Publication
330 West 42nd Street
New York 36, New York

ABP ABC

Feeds, stakes and fuses Eyelets in PRINTED CIRCUIT Boards

WITH 100% RELIABILITY

In every environmental test!

EDWARD SEGAL
MODEL NR-ESSM
automatic eyelet
attaching machine

This revolutionary machine, *supplied as a complete installation*, is obsoleting manual eyelet attaching and soldering. Leading manufacturers, in many cases using batteries of them, find Segal's new Model NR-ESSM is a completely dependable automatic method of making continuous electrical circuits of the printed elements on opposite sides of a board — or a single side if desired. Stakes and fuses 30 eyelets or more a minute, top and bottom, with never a reject.

There are other models for cold staking flat and funnel type eyelets, and for feeding and staking tube pins and turret terminals with equal reliability. All are highly economical. Segal can improve *your* eyelet attaching production. Write section E-1.

Edward Segal

Manufacturers of eyeleting machinery, special hoppers and feeding devices
132 LAFAYETTE STREET, NEW YORK 13, N.Y.

CIRCLE 204 ON READER SERVICE CARD

For LABORATORY or INDUSTRIAL APPLICATION with COMMERCIAL or MIL-SPEC REQUIREMENTS

SPECIFY

SYSTRON COUNTERS

• RELIABLE BEAM-SWITCHING COUNTING DECADES
• IN-LINE INDICATION • 50% TUBE REDUCTION

Systron offers a complete line of standard and custom counters, precision engineered to deliver dependable, accurate results for any and all applications. Next time, specify Systron Counters, and get the finest!

The Universal Counter-Timer measures: Frequency from 0 to 1,000,000 cycles per second — Time intervals from 1 microsecond to 10^7 seconds — One or ten periods from 0 cps to 1,000,000 cps — Phase Angles from 0 to 360° — Ratio of two external frequencies. Ideal all-purpose counter.

This high speed electronic counter is combined with an accurate time base to provide an IN-LINE indication of frequency from 0 to 100,000 cps and periods from 10 microseconds to 10^7 seconds. It is ideal for use as an electronic tachometer, or a multi-purpose laboratory instrument.

Specifically for measuring subcarrier frequencies in IRIG FM/FM telemetering, Model 1043 also serves as a frequency counter for precise low frequencys. measurements. Features a normalized count of 20,000 in 1/5 second for each of 18 IRIG channels and a period selection up to 100,000 for low frequency measurements.

Where Reliability is the prime factor the one microsecond pulse paired resolution scalers offered will solve all applications. Predetermined count and/or time are offered as standard options.

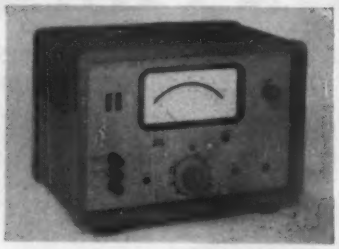
Write today for complete specifications of all models illustrated and your free copy of our Short Form Catalog.

SYSTRON CORPORATION

SYSTRON CORPORATION
Concord, California
Representatives in Principal Cities

CIRCLE 111 ON READER SERVICE CARD

On The Market



D-C Microvoltmeter

sensitive, stable

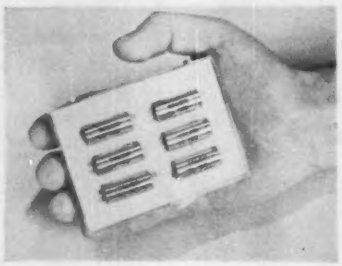
PHILIPS EINDHOVEN, NETHERLANDS. Type GM6020 d-c microvoltmeter measures direct voltages from 10 μv up to 1,000 v, direct currents from 10 $\mu\mu$a up to 10 μa. Accuracy is 3 percent. The meter is automatically switched to the polarity of the voltage or current to be measured and which is indicated by means of two luminous columns. Instrument is fully protected against overloads, and designed to be connected to any existing line voltage (40-100 cps).

CIRCLE 301 ON READER SERVICE CARD

Delay Lines

lumped constant

VALOR INSTRUMENTS, INC., 13214 Crenshaw Blvd., Gardena, Calif. Six lumped constant delay lines with delays of 0.1, 0.14, 0.2, 0.3, 0.5 and 0.7 μsec are available in kit No. 122. Each delay line has a 3 to 1 delay to rise time ratio and is



molded in a 0.4 in. by 1 in. hermetically sealed brass tube with a fused tin plate finish. Subminiature powdered iron toroidal inductors and temperature compensating ceramic disk capacitors are used in their construction. Units are designed for transistor and p-c applications.

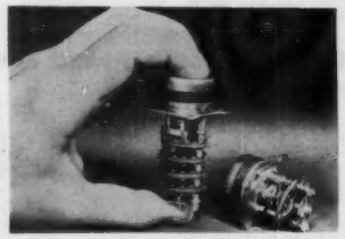
CIRCLE 302 ON READER SERVICE CARD

Rotary Switch

subminiature

G. H. LELAND, INC., 123 Webster St., Dayton 2, Ohio. The Ledex BD2E subminiature assembly circuit selector weighs less than 3 oz and measures only 1.5 in. long and 1.375 in. in diameter. It can be used for stepping, counting, programming, circuit selecting and homing. The switch can hold up to four 12-position circuit wafers, with 2-, 3-, 4-, 6- or 12-electrical position selective control. Wire sizes are available to accommodate 3 to 300 v d-c, 1,000 v rms Hi-pot.

CIRCLE 303 ON READER SERVICE CARD

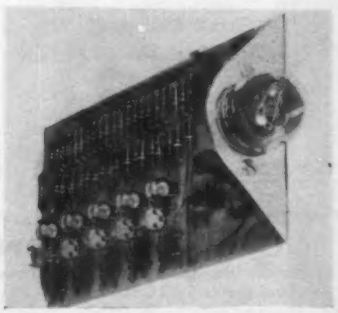


Ceramic Capacitors

five stock sizes

MUCON CORP., 9 St. Francis St., Newark, N. J. The Narrow-Caps series of ceramic capacitors are especially designed for $\frac{1}{10}$ in. modular spacing in printed circuitry; and other tight packages. Because of their size (0.095 width and 0.025 length), they have an average component density of approximately 1,500,000 units to the cu ft or approximately 900 to the cu in. Capacitance values in five stock sizes are 100 $\mu\mu$f, 250 $\mu\mu$f, 500 $\mu\mu$f, 750 $\mu\mu$f and 1,000 $\mu\mu$f. Tolerance is $\pm$20 percent, and body length of the first four sizes is 0.250 in. maximum, while the length of the 1,000 $\mu\mu$f unit is 0.300 in. maximum. Temperature range is -60 C to $+125$ C.

CIRCLE 304 ON READER SERVICE CARD



Converter

binary to decimal

HERMES ELECTRONICS CO., 75 Cambridge Parkway, Cambridge 42, Mass. Model 260 solid state binary to decimal converter is designed as companion equipment for computers which require decimal display readout for any number of four bit code inputs. Unit activates a cold-cathode decimal display equivalent to a Nixie tube. Filamentary projected readout equivalent to IEE alphanumeric unit is available on special order. Model 260 is available as a single plug-in module complete with illuminated display or as an assembly of a number of modules which are packaged for convenient mounting in a standard RETMA rack.

CIRCLE 305 ON READER SERVICE CARD

(Continued on p 114)

are you silicon wait-bait?

avoid unnecessary delays
GT DELIVERS SILICON TRANSISTORS IN 24 TO 48 HOURS!

No need to get hung up with delays or hooked by unkept promises! GENERAL TRANSISTOR delivers sample quantities of GT Silicon Transistors in 24 to 48 hours... production quantities in 2 to 4 weeks!

These are not mere claims, but firm promises on which you can base your design and production schedules.

Quality? Yes—plenty of weight here without waiting. General Transistor is today one of the largest suppliers of highly dependable devices, delivering **quality** in **quantity.**

For full information—**and fast delivery**—call your local General Transistor representative, or contact us directly. Write for Silicon Brochure S-100.

GENERAL TRANSISTOR CORPORATION

91-27 138th Place, Jamaica 35, New York
Phone: Hickory 1-1000

A Few of the GT Alloyed Junction Silicon Transistors Now Available

- **HIGH SPEED SWITCHING**
- **MEDIUM SPEED SWITCHING**
- **HIGH VOLTAGE**
- **HIGH SPEED LINEAR AMPLIFIER**
- **MEDIUM SPEED LINEAR AMPLIFIER**

PNP:	2N1219	2N1220	2N1221	2N1222	2N1223
V_{CBO}	30 v	30 v	30 v	30 v	40 v
V_{CEO}	25 v	25 v	25 v	25 v	40 v
V_{EBO}	20 v	20 v	10 v	10 v	10 v
I_{CO}	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.
h_{FE}	18 min.	9 min.	——	——	——
f_{ab}(mc)	5 min.	2 min.	5 min.	2 min.	2 typ.
h_{fe}	——	——	18 min.	9 min.	6 min.

FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. PRECISION MAGNETIC RECORDING HEADS AVAILABLE FROM GENERAL TRANSISTOR WESTERN CORP., 6110 VENICE BLVD., LOS ANGELES, CALIF.

CIRCLE 113 ON READER SERVICE CARD

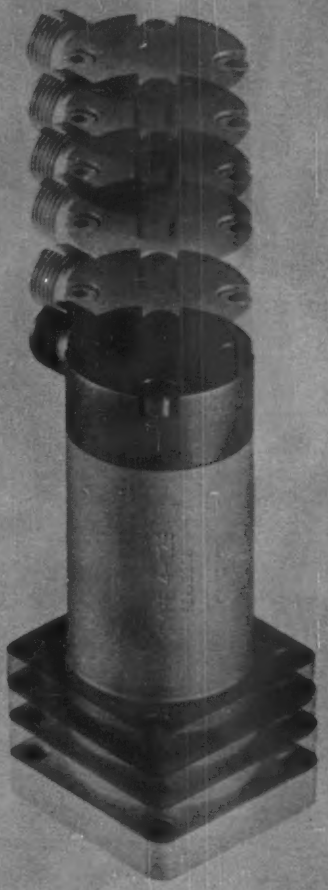
CIRCLE 114 ON READER SERVICE CARD→

even in toughest environments,

CEC's 4-123 transducer

DETECTS VIBRATION IMMEDIATELY

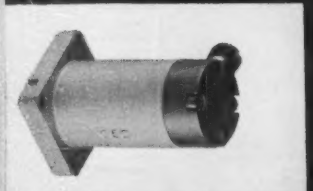
A hint of vibration in a jet engine or in engine test cells is detected instantly by CEC's omnidirectional 4-123 vibration transducer. This rugged pickup assures a frequency response of 45 to 2000 cps . . . provides constant damping over an operating temperature range of −65°F. to +500°F.



Hermetically sealed against sand and dust, the 4-123 functions perfectly in oily, corrosive and humid atmospheres. It weighs only 4.25 oz., including connector, and is 2⅛" high.

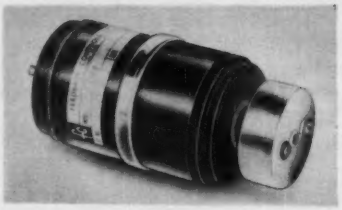
Wherever unbalance is present—in engines, machinery, motors or generators—CEC's line of vibration transducers ensures fast detection, quickly helps solve your vibration problems.

For complete information, call your nearest CEC sales and service office or write today for Bulletin CEC 1596-X13.



Transducer Division CEC

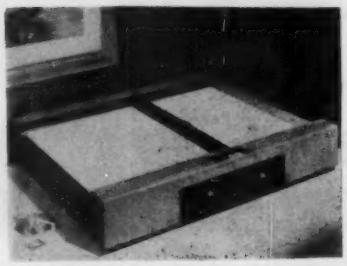
CONSOLIDATED ELECTRODYNAMICS / pasadena, california



Inertia Damper viscous-coupled

FEEDBACK CONTROLS, INC., 8 Erie Drive, Natick, Mass. New viscous-coupled damper is designed for use in applications requiring high velocity and high torque constants with good stability. It consists of a flywheel, free to rotate inside a low-inertia shell rigidly fastened to the servomotor shaft. The damping action is produced by a special viscous fluid between the flywheel and shell. Unit is available in two models with a diameter of 1.52 or 1.79 in., and with 10 time constants ranging from 0.02 to 1.20 sec. Damping action is factory-set for the life of the unit.

CIRCLE 306 ON READER SERVICE CARD



X-Y Plotter 24 by 36 in.

HOUSTON INSTRUMENT CORP., 1717 Clay Ave., Houston 3, Texas. The HR-94 X-Y recorder is designed to operate from differential transformers. It may be used to plot small mechanical movements or any related variables which can be converted to mechanical movements. First application is in plotting contours of miniature bearing races. Other applications include mechanical inspection, plotting surface and gear tooth irregularities, stress, strain, pressure, spring and bellows deflections, etc. Multiplication factor is adjustable to 1,000:1 with total error less than 0.15 percent. Twenty microinch movements are

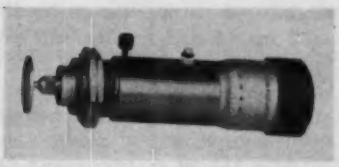
readily detectable. Pen speed with standard servo is 2 ips. Speeds up to 20 ips and electronic subassemblies to operate from low level d-c inputs are available on special order. Domestic price is $3,200.

CIRCLE 307 ON READER SERVICE CARD

Unit Indicator for T-PAC modules

COMPUTER CONTROL CO., INC., 983 Concord St., Framingham, Mass., announces model UI-10 unit indicator for use with its line of T-PAC modules. Each UI-10 displays the output of a logical element package (model LE-10) or a static flip-flop (model FS-10), and contains provision for driving an external indicator. Power requirements:—90 v, 1 ma minimum to 2.3 ma maximum. Input requirements: accepts +0.6 v, at 0.1 ma from the LE-10; or —12 v, at 0.2 ma from the FS-10; or 1 mc pulses, 2.5 v minimum amplitude.

CIRCLE 308 ON READER SERVICE CARD

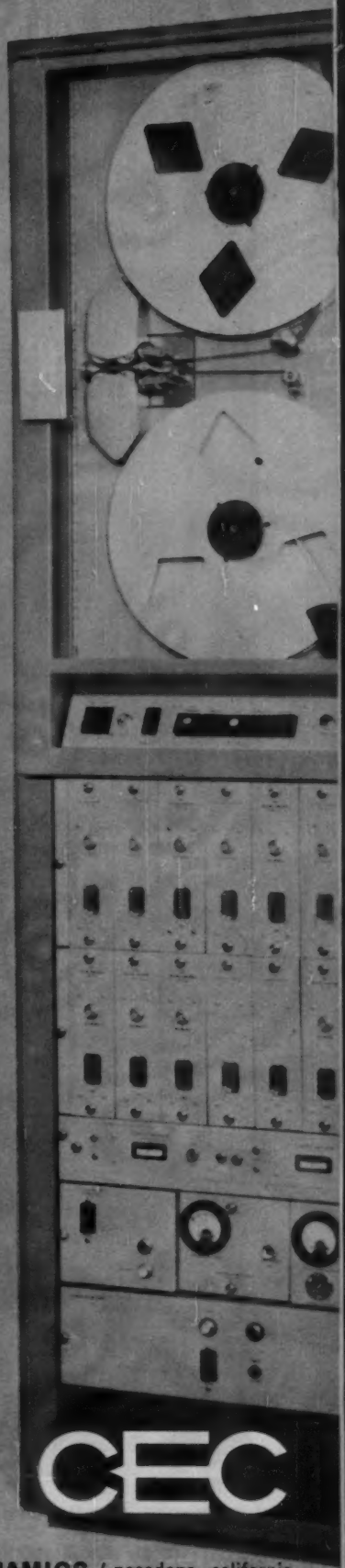


Transducer displacement type

PHOTOCON RESEARCH PRODUCTS, 421 N. Altadena Drive, Pasadena, Calif. Model PT5 proximity transducer was developed to measure small mechanical displacements from 0 to 20,000 cps with the Photocon Dynagage measuring system. It can be calibrated under dynamic

if you think this looks like CEC'S 5-752...

YOU'RE ONLY HALF RIGHT



The picture shown here is of a new, improved version of the famous 5-752 Recorder/Reproducer. We call it Model 5-752A, and it represents the culmination of years of engineering time and practical experience.

Never before such versatility.

Pick a mode... any mode: Analog, FM, PDM, CM, Digital. CEC's new 5-752A can handle any or all of them, with interchangeable Plug-In Amplifiers for five modes of recording or playback.

Monitoring versatility too.

The 5-752A features optional monitoring, either local or remote, of Signal Input/Output. True head-current monitoring also.

New features.

The cabinet is tougher than ever... it's all-steel, all-welded... all-rigid, too, for such rough environments as mobile or marine installations. And a new, metal-framed, transparent cover closes dust-tight on a gasket seal... gives protection where it counts, over the tape and heads.

Specially designed CEC Current Amplifiers slide right into place... boost reproduce amplifier signal output... give galvanometers, chart recorders, and other allied instrumentation the whole story, loud and clear.

For complete information on this most versatile of instrumentation recorders, call the CEC sales and service office nearest you, or write for Bulletin CEC 1576-X41.

DataTape Division

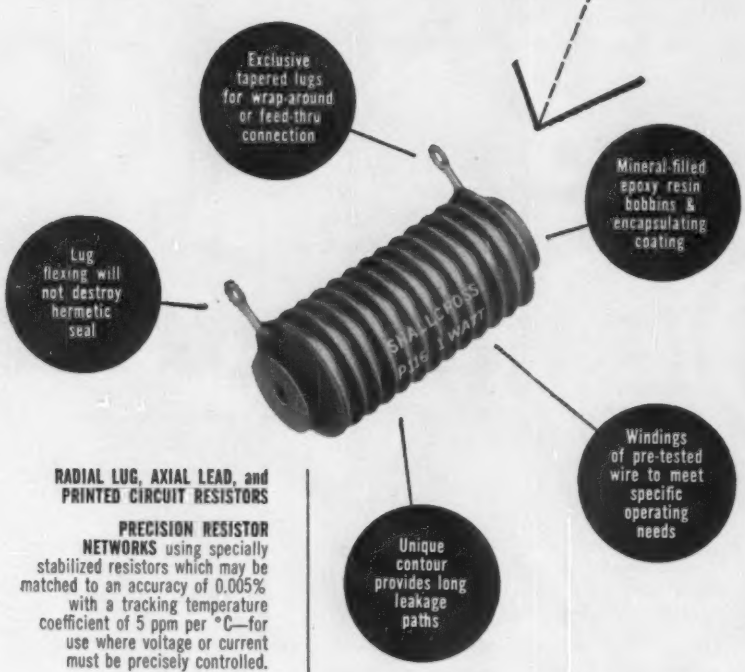
CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

...Where only a Precision Wirewound is **Precise** Enough!

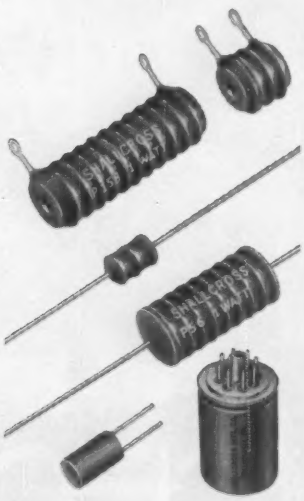
Shallcross

"P" type RESISTORS


Exclusive tapered lugs for wrap-around or feed-thru connection
Mineral-filled epoxy resin bobbins & encapsulating coating
Lug flexing will not destroy hermetic seal
Windings of pre-tested wire to meet specific operating needs
Unique contour provides long leakage paths

RADIAL LUG, AXIAL LEAD, and PRINTED CIRCUIT RESISTORS

PRECISION RESISTOR NETWORKS using specially stabilized resistors which may be matched to an accuracy of 0.005% with a tracking temperature coefficient of 5 ppm per °C—for use where voltage or current must be precisely controlled.



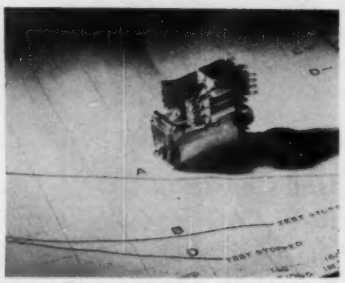
As specialists in precision wirewound resistors and resistor assemblies for over 30 years, Shallcross offers unmatched experience in meeting the most exacting matched resistor requirements. Encapsulated "P" Types illustrated are available in over 25 basic types—many to critical MIL-R-93A, MIL-R-93B, and MIL-R-9444 Specifications. Detailed performance comparisons to applicable MIL specs are available for all types.

SHALLCROSS MANUFACTURING CO., 2 Preston St., Selma, N. C.

←CIRCLE 115 ON READER SERVICE CARD

operating conditions. A micrometer head on the transducer is calibrated directly in 0.0001 in. Output of the Dynagage should be displayed on a direct coupled c-r oscillograph. By rotating the micrometer head on the transducer, any point on the oscilloscope trace can be measured in reference to any other point, by displacing the oscillograph trace until the first point is displaced to correspond with the location of the second point.

CIRCLE 309 ON READER SERVICE CARD



Telephone Relay highly reliable

PHILLIPS CONTROL CORP., 59-T W. Washington, Joliet, Ill. Type 8 is an extremely flexible telephone type relay. During rugged life comparison tests it was still going after 200,000,000 operations made at a pace of 10 pps. Rugged, cup mounted glass Teflon spring and armature bushings are incorporated with new design techniques. Unit provides fast make and break for maximum number of circuits. The long coil construction permits the use of high resistance coils and it is engineered to operate on as little as 2 ma. Relay is ideal for communication and military applications, as well as for a wide variety of data processing and other electronic equipment.

CIRCLE 310 ON READER SERVICE CARD

Computer Diodes low capacitance

PACIFIC SEMICONDUCTORS, INC., 10451 W. Jefferson Blvd., Culver City, Calif. Series 1N925 through 1N928 are extremely low capacitance, very fast recovery silicon computer diodes. Maximum inverse

...IT GLOWS *when the* FUSE BLOWS!

NEW INDICATING 3AG FUSE POSTS

EXAMINE THESE FEATURES

1. New patented knob design to assure high degree of illumination for instant blown fuse indication.
2. Positive finger grip for knob extraction.
3. Quick service bayonet lock.
4. Constant tension beryllium copper coil & leaf spring for positive contact & lower millivolt drop.
5. Optional—at extra cost—neoprene "O" ring to assure splash-proof feature.
6. New high degree vacuum neon lamp for greater brilliance & visibility.
7. Impact black phenolic material in accordance with MIL-M-14E type CFG.
8. One piece brass hot tin dipped non-turning bottom terminal.
9. Double flats on body to permit mounting versatility.

SPECIFICATIONS:

PART #	VOLTAGE RANGE
344006	2½- 7 volts
344012	7 - 16 volts
344024	16 - 32 volts
344125	90 -125 volts
344250	200 -250 volts

Maximum current rating 20 amps.

PHYSICAL CHARACTERISTICS—Overall length 2⅜" with fuse inserted • Front of panel length ¹³⁄₁₆" • Back of panel length 1⁹⁄₁₆" • Panel area front ¹³⁄₁₆" dia. • Panel area back ¹³⁄₁₆" dia. • Mounting hole size (D hole) ⅝" dia. flat at one side.

TERMINAL—Side—one piece, .025 brass—electro-tin plated • Bottom—one piece, lead free brass, hot tin dipped.

KNOB—High temperature styrene (amber with incandescent bulbs —2½ thru 32 volts—and clear with high degree vacuum neon bulbs—90 thru 250 volts) • Extractor Method—Bayonet, spring grip in cap.

HARDWARE—Hexagon nut—steel, zinc cronak or zinc iridite finish • Interlock lock washer—steel, cadmium plated • Oil resistant rubber washer.

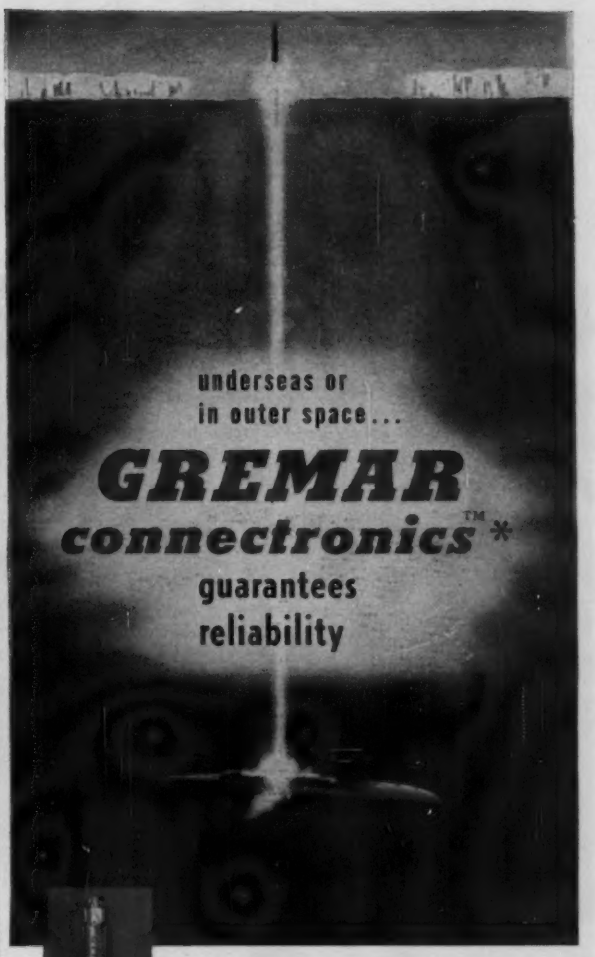
MILITARY SPECIFICATIONS—MIL-M-14E type CFG. Fungus treatment available upon request per Jan-T-152 & Jan-C-173.

TORQUE—Unit will withstand 15 inch lbs. mounting torque.

LITTELFUSE

DES PLAINES, ILLINOIS

CIRCLE 205 ON READER SERVICE CARD

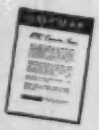


GENERAL DYNAMICS' Electric Boat Division specifies Gremar hull antenna fittings for our latest atomic powered, POLARIS — armed, missile subs: George Washington and Patrick Henry. Why Gremar?

*BECAUSE GREMAR CONNECTRONICS™ concentrates engineering, production and quality control on RF Connectors *only* . . . guarantees 100% conformance to your most exacting specs.

BECAUSE GREMAR DELIVERS . . . by stocking America's most complete line of RF Connectors and Fittings . . . by maintaining a shelf stock of more than 500,000 assembled units . . . of over 2,000 types . . . and 4,000,000 component parts ready for fast assembly!

SPECIFY GREMAR for top-level reliability and performance in RF Connectors. Write for literature on any series of standard RF Connectors . . . or send us your specs on special requirements.



Helium mass spectrometer leak test performed on critical hermetic seal problems can detect a leak that would pass only 1 oz. of fluid in 500 years! Just one of 142 separate quality checks performed to make Gremar RF Connectors specified for use in all major missile programs.

GREMAR

MANUFACTURING COMPANY, INC.

RELIABILITY THROUGH QUALITY CONTROL

Dept. A Wakefield, Mass., CRystal 9-4580

CIRCLE 117 ON READER SERVICE CARD

Waters has a watertight case!

APW½ ½" dia.

Waters APW½ Sealed Potentiometer is so watertight and so heat resistant that it operates reliably even in boiling water! The APW½ is completely unaffected by humidity and water vapor, the two common causes of potentiometer failures in aircraft and missiles, where pressure and altitude changes allow equipment "to breathe". Naturally, the watertight construction of the APW½ also seals out dust and other minute particles which might cause failure. Meets MIL-E-5272A immersion specifications by means of a double "O" ring shaft seal. The glass-to-metal terminal board is solder-sealed to the case. Available with 125°C or 150°C construction, mechanical rotation stops, special winding angles, values to 100K and tighter linearity tolerances. Can be supplied with optional split bushings and various shaft lengths. (Waters WPW½ Sealed Potentiometer features the same construction as the APW½, but with a servo face.) Write for Bulletin APW-359.

Waters
MANUFACTURING, INC.
WAYLAND, MASS.

POTENTIOMETERS
SLUG TUNED COIL FORMS
RF COILS
CHOKES
POT HOOK® PANEL MOUNTS
TORQUE WATCH® GAUGES
C'TROL METER/CONTROLLER INSTRUMENTS

118 CIRCLE 118 ON READER SERVICE CARD

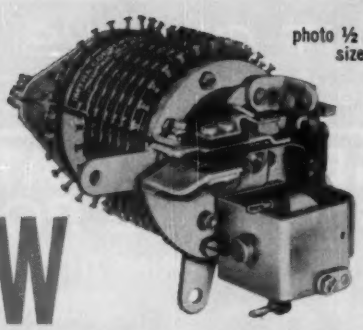


photo ½ actual size

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HIGH-SPEED, MINIATURE STEPPING SWITCH

For: Automatic switching, circuit selection, and timing-control

Featuring: • 80 steps per second on impulse drive • 30 contacts per bank • maximum 12 banks • only 17 oz. in weight • unique sequence switching

Write today for complete technical data on the unique Miniature Uniselector — ALSO on the Two-Way and One-Way Stepping Switches.

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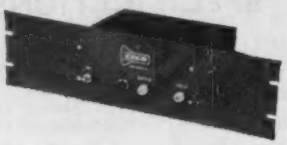
CIRCLE 206 ON READER SERVICE CARD

CECO



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VHF and UHF
Amplifiers and Preamplifiers
SERIES 1000

For application as receiver preamplifiers or wide band i. f. amplifiers . . . in scatter communications systems, laboratory, or nuclear research. Eight standard models cover VHF and UHF to 900 mc. High gain, low noise. Special pass bands available.

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MUCON perfects a new family of SUBminiature CERAMIC CAPACITORS

NARROW-CAPS to fit 1/10 INCH MODULAR SPACING

"NARROW-CAPS" subminiature ceramic capacitors and 1/10 inch modular spacing of printed circuitry form the newest 'hand-in-glove' team to speed the still smaller assemblies required today.

5 CAPACITANCE VALUES in STOCK

100 mmf. ± 20% . . . 250 mmf. ± 20%
500 mmf. ± 20% . . . 750 mmf. ± 20%
1000 mmf. ± 20% with ambient temperature range –60°C. to 125°C. and a voltage rating of 50WVDC.

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Consistently Perfect
FINE PITCH GEARS
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- Exacting tolerances held . . . from commercial grade to ultra precision.
- Generated in wide range of steels, non-ferrous metals, and non-metallic materials.
- Capacity range: 12 to 200 d.p., and maximum O.D. of 7½".

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Avon is completely tooled to follow your specifications precisely, and to produce the very best precision or commercial grade Fine Pitch gears for your specific needs. At Avon you can get one gear . . . or a million of ALL types, ALL classes, from ALL materials.

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CIRCLE 221 ON READER SERVICE CARD

Waters has an airtight case!

Waters APH½ hermetically sealed precision potentiometer, in addition to maintaining the hermetic seal behind the panel, is itself tightly sealed against outside atmosphere and salt spray by means of a double "O" ring shaft seal. The entire potentiometer passes Liquid Immersion Tests per MIL-E-5272A, par. 4.12.1, and, excluding the shaft, passes the Mass Spectrometer Test with leak rate less than 10^{-7} CC/sec. N.T.P. Pre-tinned, it can be easily soldered into the panel. Its terminal lugs are installed with a glass to metal seal, and are positioned for easy wiring. The brass case is plated in conformance with military requirements. Waters APH½ HT Potentiometer also has high temperature operating characteristics. It derates to zero watts at 150°C; ¾ watts may be safely dissipated at 125°C. Available with mechanical rotation stops, special winding angles, resistance values to 100K ohms and tighter linearity tolerances. Write for Bulletin APH.

POTENTIOMETERS
SLUG TUNED COIL FORMS
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CHOKES
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CIRCLE 119 ON READER SERVICE CARD

Plug-in CALI-MARKER®
Calibrator & Time-Mark Generator
The first compact, plug-in unit of its kind. Combines a stable, square-wave calibrator and a crystal-controlled time-mark generator. Interchangeable with a second plug-in sweep generator.
RECTANGULAR & SQUARE
2- and 4-Gun Tubes
. . . exclusive with ETC, give raster areas equal to 7" round tubes.
Plug-in SWEEP GENERATORS
One or two identical plug-in sweeps may be used on each instrument for common or separate calibrated time bases as needed. Second sweep interchangeable with Cali-Marker.
Plug-in PRE-AMPLIFIERS
Choice of 5 types for each channel. Matches sensitivity and response requirements from 50 mv/cm to 50 μv/cm, dc to 50 kc to 5 mc. Any combination of pre-amplifiers may be used simultaneously on all channels.

4-channel, Model K-470 illustrated.

THE WORLD'S MOST VERSATILE OSCILLOSCOPES!

with Plug-ins for All Needed Ranges . . .
All Needed Features . . . No Obsolescence.

2- and 4-Channel Types

Models K-270 and K-470 . . .

Display multiple, high-speed signals *without* switching. From DC to 5 megacycle bandwidths.

Here is true multi-channel oscillography with features, performance, and prices "tailored" to your exact needs. Versatile plug-in pre-amplifiers, sweeps, and marker-calibrator circuits need be purchased only *as* you need them . . . when you need them. No worries of having "too much" scope now . . . not enough scope flexibility a few years later.

From simple one-channel monitoring jobs to difficult medical, biophysical and low-level strain gauge recording involving two, three or four channels, you'll find no jobs too small or few too large for these versatile ETC instruments.

Write for detailed specifications and prices.

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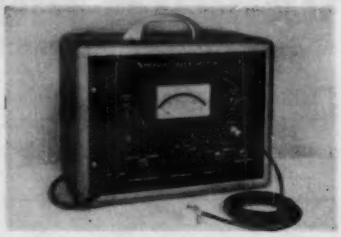
PIONEERS IN MULTI-GUN C-R TUBES AND MULTI-CHANNEL OSCILLOGRAPHY.

120 CIRCLE 120 ON READER SERVICE CARD

capacitance is 4.0 $\mu\mu$f at zero voltage and typical inverse capacitance, 1.1 $\mu\mu$f at −10 v. Maximum recovery time is 20 K at 0.15 μsec switching from 5 ma to −10 v. The diodes are furnished in the new smaller diameter (0.125 max.) PSI package.

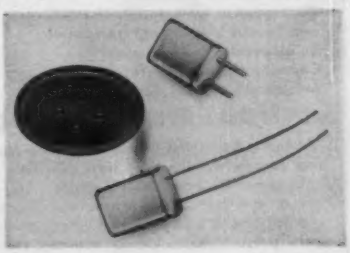
CIRCLE 311 ON READER SERVICE CARD



Peak Accelerometer accurate unit

FERRANTI ELECTRIC INC., 95 Madison, Hempstead, L. I., N. Y. This instrument was developed for accurate measurement of true peak "g" in shock and vibration tests. A barium titanate transducer is connected to a specially designed amplifier and indicator unit which retains the peak reading for 15 sec for shock measurements or follows the peak acceleration reading when the instrument is set to make vibration measurements. Four ranges are provided for accelerations up to 1,000 "g" which are indicated on a 3½ in. meter with a mirror scale and a knife-edge pointer.

CIRCLE 312 ON READER SERVICE CARD

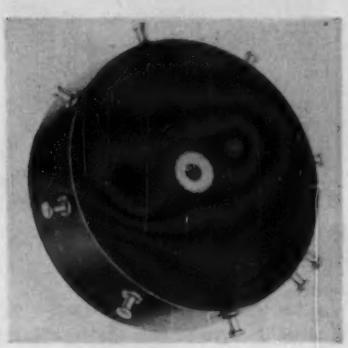


Quartz Crystal subminiature

THE KEYSTONE ELECTRONICS CO., 65 Seventh Ave., Newark 4, N. J. Type KC-43A quartz crystal is available in subminiature HC-18/U military-type holders. It has a frequency range of 4 mc through 150 mc, with a frequency shift of less

than ±0.0025 percent over a temperature range of −55 C to +105 C. In type Sm-43, the quartz crystals are available for high shock, vibration and other extreme environmental conditions. Physical dimensions of the KC-43A are: pin diameter, 0.017; pin spacing, 0.192; body height, 0.530; body width, 0.402; body thickness, 0.150. On the plug-in unit, pin diameter is 0.040.

CIRCLE 313 ON READER SERVICE CARD



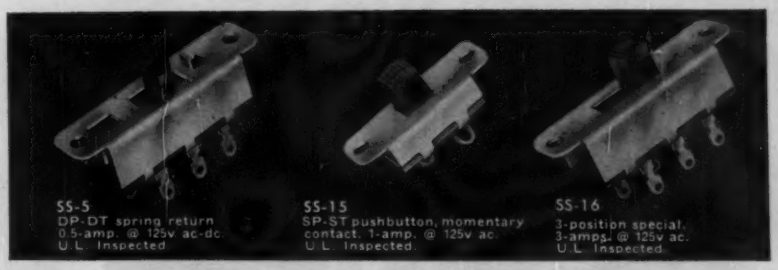
Transformers toroidal type

BARKER & WILLIAMSON, INC., Bristol, Pa. Toroidal transformers suitable for transistorized power supplies are encapsulated to meet all requirements of sealed construction and are designed to perform satisfactorily within a temperature range of −55 to 130 C. Line includes transformers of 25, 60 and 120 w ratings and a 25 w inverter which generates 26 and 115 v 400 cycles. The transformers operate on 12 to 14 v d-c input. Prices range from $8.10 to $15.25.

CIRCLE 314 ON READER SERVICE CARD

Silicon Rectifiers two series

DELCO RADIO DIV., General Motors Corp., Kokomo, Ind., offers silicon rectifiers consisting of four models each in two series—rated at 40 and 22 amperes for continuous duty up to ambient temperatures of 150 C. Both series offer a low maximum reverse current of 5.0 ma at maximum rated temperature and peak inverse voltage. The 22 ampere series has four models—1N1191A through 1N1193A—in 50 v steps from 50 v



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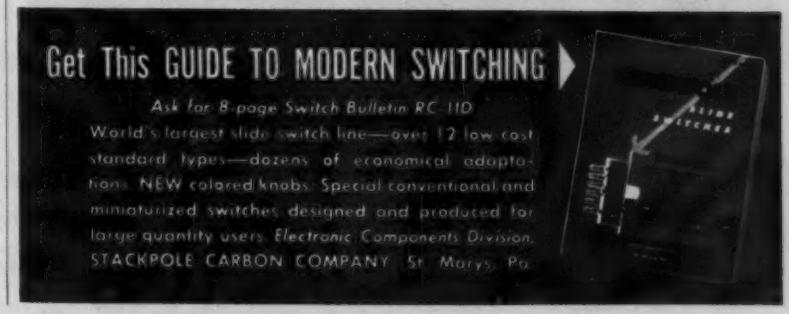
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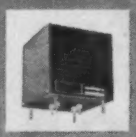
World's largest slide switch line—over 12 low cost standard types—dozens of economical adaptations. NEW colored knobs. Special conventional and miniaturized switches designed and produced for large quantity users. Electronic Components Division.
STACKPOLE CARBON COMPANY St. Marys, Pa.



WHAT
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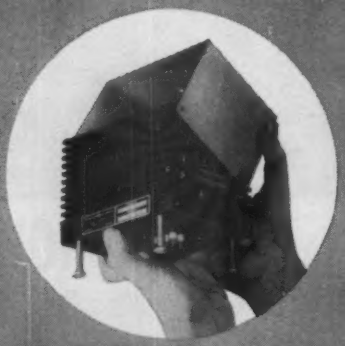
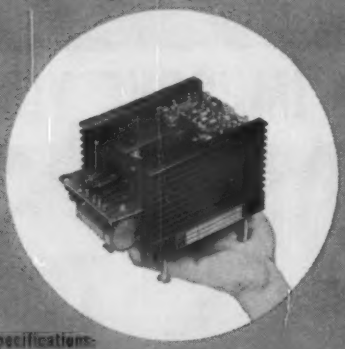
AC-DC "PLUG-IN"
TRANSISTORIZED
POWER SUPPLY
DESIGN
GIVES YOU...



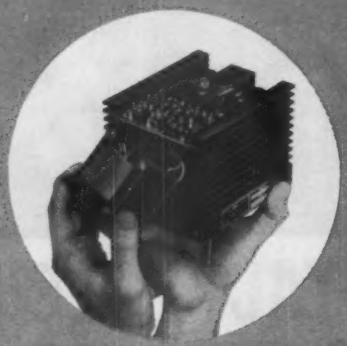
One piece finned aluminum extrusion, achieving high heat dissipation. Most units need no external heat sink to 55° C ambient. All units have adjustable output. Platform mounted standardized subassemblies and components enable quick delivery of a wide range of voltages and currents.



Specifications:
Input: 105 to 125V AC, 45 to 420 cps, single phase
Regulation: 0.1% (line or load)
Stability: Better than 0.25% for 8 hours
Ripple: 0.02% rms
Response time: less than 100 microseconds
Low dynamic impedance

Designed primarily as a component power supply, units are widely used in computors, electronic instrumentation, production test equipment, and quality control check out systems. Best of all, the unique design makes these units available at the lowest possible cost to you.

(Unit pictured above: Model #1R 90-.1; 85-95 V; 0-100 ma; Price $145.00) Prices on other units range from $100 to $200.



All solid state — zener diode reference; transistor amplifiers and regulator
Output Voltages: from 2.0 to 300V DC
Output Power to 30 Watts
Reliable short circuit protection
All components readily accessible

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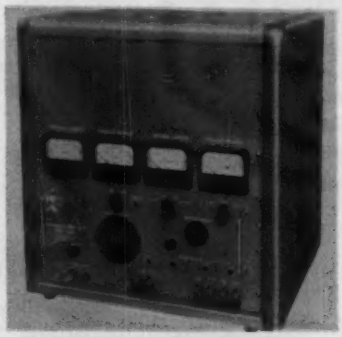
piv to 200 v for the 1193A model. The 40 ampere series (1N1183A through 1N1186A) also run from 50 v through 200 v. Maximum forward drop for the 22 series is 1.2 v while only 1.1 v for the 40 series.

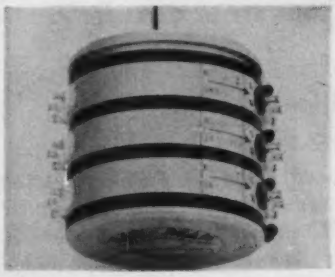
CIRCLE 315 ON READER SERVICE CARD



Rectifier Test Set
20-ampere unit

WALLSON ASSOCIATES, INC., 912 Westfield Ave., Elizabeth, N. J. Model 141A is a completely self-contained dynamic rectifier test set for incoming inspection, on-line testing and laboratory use. Forward current and reverse voltage controls are independently adjustable. Forward current range is 0-1, 10, 20 amperes d-c average, with a reverse voltage peak of 0-1,000. It measures a forward drop range of 0-$\frac{1}{2}$ v and a reverse current range of 0, 0.05, 0.5, 5, 50 ma average. Permanent provisions are made for monitoring all four parameters with an external oscilloscope.

CIRCLE 316 ON READER SERVICE CARD



Dual Pots
low torque

ME-MAR ELECTRONICS CORP., 2716 E. Huntington Dr., Duarte, Calif. Precision single turn dual element pots feature: $\frac{3}{4}$ in. to 3 in. diameter, $\frac{3}{8}$ in. thick, various shaft and

NOW YOU CAN SPECIFY SPERRY FOR 2N327A 2N328A 2N329A 2N330A

SILICON PNP TRANSISTORS IN PRODUCTION QUANTITIES

Newly-added to the world's widest line of general-purpose PNP silicon transistors, these popular types are available immediately for your audio, switching and control applications.

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Like all other Sperry transistors, these units feature new low levels of I_{CO} and are baked at 200°C for 200 hours for utmost stability. For immediate delivery on the 2N327A series, contact the nearest Sperry sales office as listed below.

And don't forget these other recently-announced types for which you can now SPECIFY SPERRY:

2N1034	2N1219
2N1035	2N1220
2N1036	2N1221
2N1037	2N1222
2N1275	2N1223

SPERRY

SPERRY SEMICONDUCTOR DIVISION, *SPERRY RAND CORPORATION, SOUTH NORWALK, CONNECTICUT*
Call or write: *Sperry Semiconductor, Wilson Avenue, SOUTH NORWALK, Conn., VOlunteer 6-1641; in NEW YORK PLaza 2-0885; 3555 W. Peterson Ave., CHICAGO 45, Ill., KEystone 9-1776; 2200 East Imperial Highway, EL SEGUNDO, Calif., ORegon 8-6226.*

CIRCLE 123 ON READER SERVICE CARD

Look beyond the obvious...

... as you consider *your* future in the electronics industry. First, what is the obvious? It's obvious that you're in demand. You don't have to worry about getting your material wants satisfied.

But, when you look beyond the obvious, you realize that you want something more than simple "want satisfaction" out of your career. You want *pride*—pride in the importance of your personal, *individual* contribution.

At Melpar, where we are now working on 120 advanced defense and space exploration projects, we have significant opportunities for the professional engineer or scientist who wants to be proud of his contribution to advancing the state of electronic art.

Senior-level positions are available in the following areas at this time:

Reconnaissance Systems	Detection & Identification Systems
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Ground Data Handling Equipment	Physical Sciences Laboratory
Simulation & Training Systems	Production Engineering
Communication & Navigation Systems	Quality Control
Ground Support Equipment	Field Service Engineering

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MELPAR INC.

A SUBSIDIARY OF WESTINGHOUSE AIR BRAKE COMPANY
3323 Arlington Boulevard, Falls Church, Virginia
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10 miles from Washington, D. C.

mount combinations, all metal exterior, external phasing with precision clamp bands, gold anodize finish and screw-in terminals. Resistance is to 200 K ohms, linearity to 0.05 percent, high temperature 150 C, and life exceeds 2 million operations. Pots are gangable to 30 units.

CIRCLE 317 ON READER SERVICE CARD

Subminiature Jack guided-entry

SEALECTRO CORP., 139 Hoyt St., Mamaroneck, N. Y. Type SKT-50 Press-Fit jack takes the inserted probe almost blindly. The guided-entry feature is an improved version of the SKT-5BC test jack with the advantages of elimination of binding, more rigid holding of probe after insertion, and greater electrical insulating properties. The jack accepts a 0.080 in. diameter probe with maximum length of 0.310 in.

CIRCLE 318 ON READER SERVICE CARD

Zener Diode high power

U. S. SEMICONDUCTOR PRODUCTS, 3540 W. Osborn Road, Phoenix, Ariz., has developed a high power Zener diode with standard tolerance of 5 percent in single units. No matched pairs are needed to achieve this tolerance. Space and weight are saved, while power dissipation up to 35 w is easily attained in a single Zener with proper heat sink. Zener voltages range from 8.2 to 100 v at 500 to 50 ma. Zener or dynamic impedance is low, and

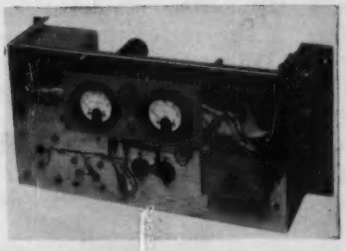
breakdown is abrupt over the whole Zener voltage range.

CIRCLE 319 ON READER SERVICE CARD

Converter
true rms to d-c

EPSCO, INC., 275 Massachusetts Ave., Cambridge, Mass. Model MCV-910 true rms to d-c converter is designed exclusively for optimum performance at those frequencies most commonly encountered in precision gyro testing. It generates a d-c output voltage that is directly proportional to the true rms value of an a-c input signal. The dynamic range is 10 mv d-c to 10 v d-c. The all solid-state converter is built to meet the rugged environmental requirements of MIL-E-4158B.

CIRCLE 320 ON READER SERVICE CARD



Power Supply
solid state unit

POWER SOURCES, INC., Burlington, Mass. Model PS4023 power supply has excellent regulation characteristics and low thermal drift. Operating at an input voltage of 105-125 v at 57-63 or 380-420 cps, it puts out 100 to 200 v at up to 400 ma load current. The output voltage is selectable by a six-step range switch, while a vernier pot is provided for exact adjustment of output voltage. There is less than 0.03 percent change in the set output voltage for any combination of input voltage or load current conditions. Thermal drift is held to a

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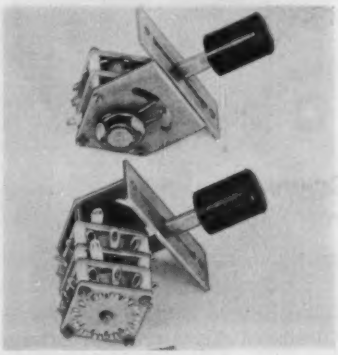
minimum. There is less than 0.006 percent per deg C change in output voltage. Total ripple and noise is less than 2.5 rms mv.

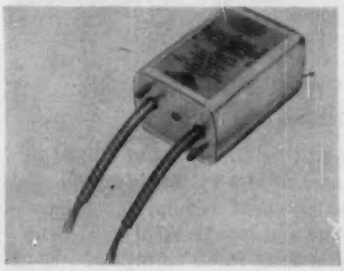
CIRCLE 321 ON READER SERVICE CARD



Miniature Switch lever-actuated

ELECTRO-SWITCH CORP., 167 King Ave., Weymouth 88, Mass. The MA-12-L provides multicircuit control, panel-mounting, and lever operation in a compact unit suitable for low-power and electronic circuits. The assembly can be furnished with either one or two sections, giving up to 12-pole switching. Switch is designed to meet MIL-S-3786. Electrical ratings: 3 amperes continuous current at 115 v a-c; interrupting rating, ½ ampere at 115 v a-c; voltage breakdown 1,000 v rms.

CIRCLE 322 ON READER SERVICE CARD



Transformer chopper input type

TRIAD TRANSFORMER CORP., 4055 Redwood Ave., Venice, Calif., announces a chopper input transformer for use with frequencies of 60 to 500 cps and with an impedance ratio of 40,000 ohms CT to 40,000 ohms CT. Model G-24 exceeds MIL-T-27A standards and has

a MIL designation of TF3R09YY. The primary and secondary of the unit is 100 percent reversible. Each winding employs the new "Box" shielding method to reduce capacitive coupling to less than 0.05 $\mu\mu$f.

CIRCLE 323 ON READER SERVICE CARD

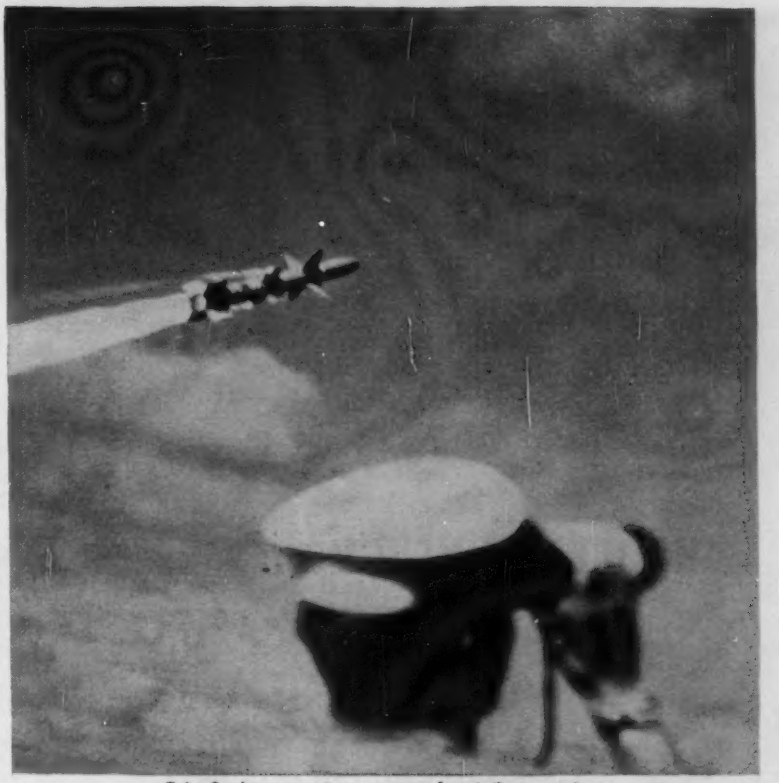
Power Supply automatic switchover

MATTHEW LABORATORIES, 3344 Fort Independence St., New York 63, N.Y. Model HCVS-250-20 constant-current and constant voltage automatic switchover regulated power supply is used primarily for tantalum capacitor production, precision electroplating, and battery charging. The application of constant current and Faraday's Law in this unit results in quantitative coulomb or electric charge transfer for the controlled formation of oxide-films or material deposition or removal. When on constant current operation at a desired current, the supply will automatically switch to constant voltage operation upon reaching a predetermined voltage due to load resistance buildup. Unit is adjustable to a maximum output of 250 v and 20 amperes.

CIRCLE 324 ON READER SERVICE CARD

Coaxial Diode tripolar

MICROWAVE ASSOCIATES, INC., Burlington, Mass. The 1N630 broadband tripolar coaxial diode is rated for use over the temperature range −40 C to +150 C. It is a direct replacement for the 1N358 tripolar diode in microwave video receivers used in video detection applications



Talos fired at sea, prime armament for missile-age cruisers.

GO MIDDLE WEST... for a prime opportunity in missiles!

Go Midwest for outstanding career opportunities with Bendix Missiles, prime contractor for the U.S. Navy Talos—first line anti-aircraft weapon aboard missile-age cruisers. Take advantage of the wide range of engineering opportunities Bendix Missiles offers you right in America's heartland! . . .

The established success of Talos by Bendix Missiles, its prime contractor, not only assures permanence of the present program but has opened the door to other advanced missile projects that offer new and challenging job opportunities in design, development, testing, and manufacturing.

Bendix Missiles, in addition to its direct responsibility for Talos and other advanced missile projects, is a key division of Bendix Aviation Corporation. The corporation-wide activities of Bendix cover practically every phase of advanced technology with particular emphasis on systems design and development. Participation in this highly diversified corporation effort is your further assurance of a more secure future.

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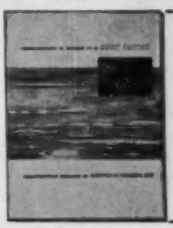
Bendix PRODUCTS DIVISION Missiles

PRIME CONTRACTOR FOR THE TALOS MISSILE



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402F So. Beiger St., Mishawaka, Ind.
Gentlemen: I would like more information concerning opportunities in guided missiles.
Please send me the booklet "Opportunities Abound at Bendix Missiles."

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from Honeywell... ANOTHER DIAMOND JUBILEE PRODUCT

WHEN YOU HAVE
extraneous common mode signals

AND WANT TO MEASURE
0.1 to 100 millivolts full scale

AND THEN AMPLIFY

CHOOSE THE NEW HONEYWELL D-C AMPLIFIER

AccuData II

wide-band differential all-transistor D-C Amplifier for strain gages and thermocouples

- **Full Scale Input:** Unbalanced: ±100 μv to ±100 mv Differential: ±3 mv to ±100 mv Open Loop: Below drift level
- **Full Scale Output:** ±2v at 50 ma, dc to 10 kc
- **Frequency Response:** to 20 kc
- **Output Impedance:** Less than 0.5 ohm at dc on all ranges
- **Input Impedance:** Unbalanced 3 to 100 mv ranges; greater than 20 megohms in parallel with 350 micromicrofarads. Differential: Greater than ± 2 megohms
- **Equivalent D-C Input Drift:** Less than 2 μv/10°F ambient temp. change on 0.1 to 30 mv input ranges
- **Equivalent Input Noise:** 4μv peak-to-peak on 100 μv to 300 μv range (0-10 cps). 8μv rms on 10 to 30 mv ranges (0 to 100 kc)
- **Common Mode Rejection:** 200,000 at 60 cps on 3 to 30mv ranges

The new Honeywell AccuData II is a completely transistorized D-C Amplifier designed for use in high accuracy data handling systems as a wide-band pre-amplifier for strain gages and thermocouples. Its output can be fed to electronic or electromechanical analog-to-digital converters and simultaneously recorded on galvanometer oscillographs or magnetic tape. Either differential or single-ended input modes can be selected by an eleven position range switch. This switch changes the gain in three-to-one steps. Intermediate gains with high resolution are provided by a ten-turn potentiometer Write for AccuData II Bulletin to Minneapolis-Honeywell, Dept. E-1, Boston Division, 40 Life Street, Boston 35, Mass.

Honeywell

First in Control

SINCE 1885

in the 1 kmc to 12.4 kmc frequency range. The 1N630 input impedance of 65 ohms is matched to standard 50 ohm coaxial lines using holders such as Sage Lab model 101 which incorporate suitable matched coaxial transitions. Minimum figure of merit is 15. Video impedance is 4,500-18,000 ohms. Tangential signal sensitivity is −40 dbm minimum.

CIRCLE 325 ON READER SERVICE CARD

Data Converter
all-transistor

ELECTRONICS ENGINEERING CO. OF CALIFORNIA, 1601 E. Chestnut Ave., Santa Ana, Calif. The ZA-25159 data converter will convert a 27-bit time code, one 20-bit data signal, and two 17-bit data signals into an IBM 704 magnetic tape. Unit will also supply signal outputs to seven central locations also in the IBM704 coding but without gaps between the blocks. The sampling rate of the input data may be selected at 10, 20, 40, 80, or 100 pps. The data converter was designed for the multiplexing and the recording of range, azimuth, and elevation data from digital radar outputs together with a timing signal.

CIRCLE 326 ON READER SERVICE CARD

Crystal Oven
accurate unit

FEDERATED ELECTRONICS, INC., 139-14 Jamaica Ave., Jamaica 35, N. Y. The BM200 quartz crystal oven holds either one or two HC-6/U crystals. It is warranted to main-

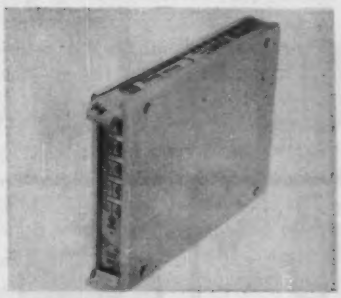
tain even temperature to ±1 deg over a 100 C ambient temperature range. Contacts are of platinum iridium.

CIRCLE 327 ON READER SERVICE CARD

D-C Power Supply
variable output

DEL ELECTRONICS CORP., 521 Homestead Ave., Mt. Vernon, N. Y. D-C power supply is rated 40 kv at 1 ma and 5 ma at 35 kv. Unit employs selenium rectifiers immersed in high grade insulating oil. Output voltage can be varied over the full range by varying the input voltage. Ripple is 0.5 percent per ma. Dimensions are 10 in. by 12 in. by 11 in. high. The unit, filled with insulating oil, weighs 70 lb.

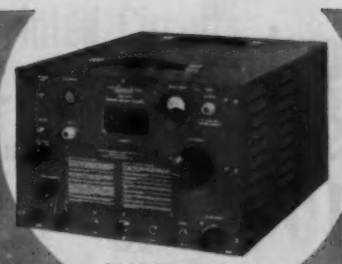
CIRCLE 328 ON READER SERVICE CARD



Shift Register
four-stage

HARVEY-WELLS ELECTRONICS, INC., East Natick Industrial Park, Natick, Mass. A new low cost, high-speed, four-stage shift register, featuring three inputs and eight outputs, may be cascaded to form a multistage shift register. It has the same electrical characteristics

MICROWAVE FREQUENCY MULTIPLIER



MODEL FM-4A

-measures 100 to 30,000mc
generates 500 to 30,000mc
with high accuracy and stability

This phase-locked oscillator transfers the accuracy and stability of a VHF driver into the microwave region, giving continuous coverage.

You can drive the unit with Gertsch frequency meters FM-3, FM-6, or FM-7. Fundamental frequency range is 500 to 1000 Mcs, with harmonic output to at least 30,000 Mcs.

Ideal for calibration of cavity wavemeters... for precise measurements, or as an ultra-stable frequency source. Unitized construction. Adaptable for rack mounting.

Gertsch

Complete data in Bulletin FM-4A.

GERTSCH PRODUCTS, Inc.

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CIRCLE 209 ON READER SERVICE CARD

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Precision wire-wound MICRO-MINIATURE RESISTORS

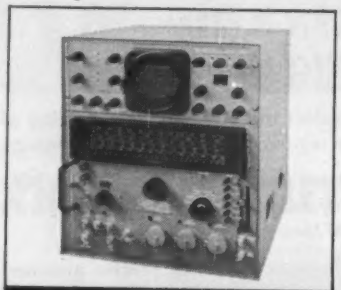
for applications where space is at a premium.

- axial and printed circuit types
- temperature coefficient of resistance ±20 PPM.
- for −65° to +150° C operation
- epoxy encapsulation
- accuracies 1% to .01%.

Write for Bulletin LC1066

CINEMA ENGINEERING
1100 Chestnut • Burbank, Calif.
DIVISION AEROVOX CORPORATION

extreme sensitivity 10 mc to 44,000 mc



PANORAMIC'S
SPA-4
SPECTRUM ANALYZER

MORE USEABLE SENSITIVITY

BAND	RF SENSITIVITY*
10— 420 MC	—95 to—105 dbm
350—1000 MC	—90 to—100 dbm
910—2200 MC	—90 to—100 dbm
1980—4500 MC	—80 to— 95 dbm
4.5—10.88 KMC	—80 to— 95 dbm
10.88—18.0 KMC	—70 to— 90 dbm
18.0—26.4 KMC	—60 to— 85 dbm
26.4—44.0 KMC	—55 to— 85 dbm

*measured when signal and noise equal 2× noise

Using one tuning head which contains one triode and two Klystron oscillators, Model SPA-4 offers more exclusive advantages for applications demanding extreme sensitivity, stability, versatility, accuracy.

- **Three precisely calibrated amplitude scales—40 db log, 20 db linear, 10 db power.**
- **Two independent frequency dispersion ranges—continuously adjustable—0-70 mc and 0-5 mc. Negligible internal frequency modulation permits narrow band analysis of FM problems.**
- **Variable I.F. bandwidth from 1 kc to 80 kc.**
- **Push-button frequency selector.**
- **Synchroscope output with 40 db gain.**
- **Accurate measurement of small frequency differences. A self-contained marker oscillator, modulated by a calibrated external generator, provides accurate differential marker pips as close as 10 kc.**

Tremendous flexibility and many unique advances of Panoramic's compact SPA-4 make it unsurpassed for visually analyzing FM, AM and pulsed signal systems; instabilities of oscillators; noise spectra; detection of parasitics; studies of harmonic outputs; radar systems and other signal sources.

Write, wire or phone today for detailed SPA-4 bulletin.

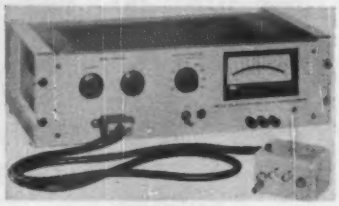
the pioneer is the leader

Panoramic
RADIO PRODUCTS, INC.

530 So. Fulton Ave., Mount Vernon, N. Y.
OWens 9-4600 Cables: Panoramic, Mt. Vernon, N. Y. State

as other units in the Data Bloc and Data Pac lines. Model 1801 replaces four standard flip flop B units for shift register applications.

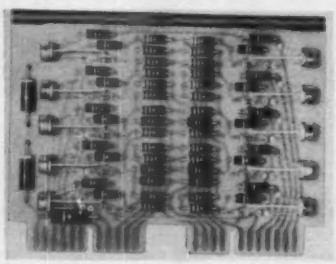
CIRCLE 329 ON READER SERVICE CARD



D-C Amplifier broad-band

KEITHLEY INSTRUMENTS, INC., 12415 Euclid Ave., Cleveland 6, Ohio. Model 603 is a broad-band d-c amplifier with 10¹¹ ohms input impedance, high voltage and current gain, and a remote differential input. Its separate input head may be operated up to 24 ft from the amplifier or plugged directly onto the panel. Other features include 9 ranges from 2.5 to 1,000 mv, with precise gains up to 4,000 and a 10-v output at 10 ma for full scale meter deflections. Bandwidth is d-c to 10 kc on the 2.5 mv range, rising to 50 kc on the 1,000 mv range. Calibration and gain accuracy are assured by over 40 db of negative feedback.

CIRCLE 330 ON READER SERVICE CARD



Nixie Driver digital module

COMPUTER CONTROL CO. INC., 983 Concord St., Framingham, Mass. The NX-101 Nixie driver is a BCD to decimal converter that accepts the 8-4-2-1 binary decimal code from a BD-101, or equivalent decimal counter, and applies appropriate drive signals to the corresponding cathode of a Nixie tube. Each

WHY ELECTRONIC CIRCUITS PERFORM BETTER WITH BENDIX SPARK GAPS

Two big jobs are performed by Bendix Red Bank Spark Gaps in electronic circuits. The first is protection against high voltage surges that might damage circuit components, as in the case of radar equipment.

The second is acting as a "triggering switch," as on the ignition systems of jet engines. Here Bendix* Spark Gaps pass high currents with relatively low voltage drop in small space.

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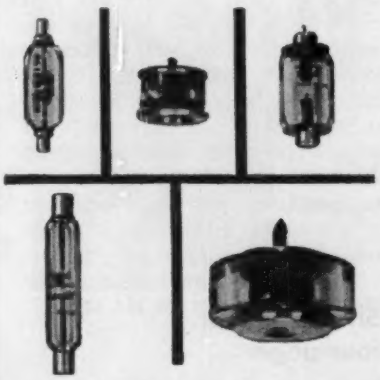


SPECIAL-PURPOSE TUBES DEPARTMENT

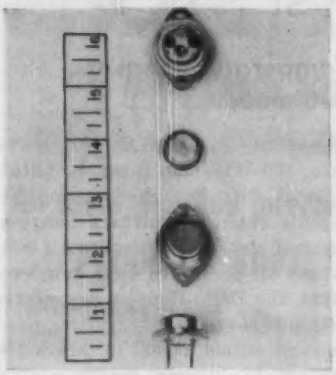
Red Bank Division
EATONTOWN, NEW JERSEY

Bendix

West Coast Sales & Service: 117 E. Providencia Ave., Burbank, Calif. • Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. • Canadian Distributor: Computing Devices of Canada, Ltd., P.O. Box 508, Ottawa 4, Ontario.

of the 10 stages consists of an *npn* transistor and a resistor decoder. The NX-101 will satisfactorily decode signals from any flip-flop capable of sustaining an additional 3 ma of current in the ON transistor and whose OFF collector potential is at a minimum of + 17 v. Power requirements: + 195 v ± 2 percent at 5.5 ma, + 20 v ± 5 percent at 9.5 ma. Input: + 18 v + 10 percent, − 5 percent at 3 ma. Output: + 20 v at 2 ma.

CIRCLE 331 ON READER SERVICE CARD



Power Transistor
military type

BENDIX AVIATION CORP., Semiconductor Products, Long Branch, N. J. The 2N1011 germanium *pnp* power transistor is designed to meet MIL-T-19500/67 (Sig. C). It has a 5 ampere maximum current rating, a current gain range of 30-75 at I_c = 3 amperes d-c, and a maximum collector-base voltage rating of 80 v. It will readily dissipate 35 w at 25 C mounting base temperature. Ideally suited to power switching and power control circuits, the 2N1011 is particularly useful in such military equipment as aircraft power supplies, missiles, and communications power supplies. Other applications are high current switching and audio amplification.

CIRCLE 332 ON READER SERVICE CARD

Milliwattmeter
Ku-band

WAYNE KERR CORP., 1633 Race St., Philadelphia 3, Pa. Type U-381 Ku-band milliwattmeter is an ex-

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ONLY CHART-PAK HAS IT!
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No waste . . . use every inch
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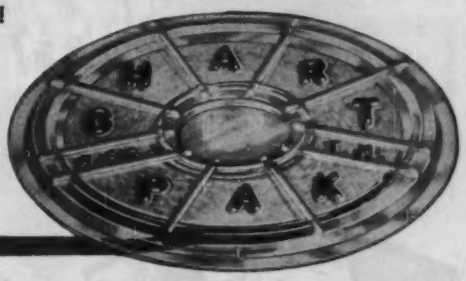

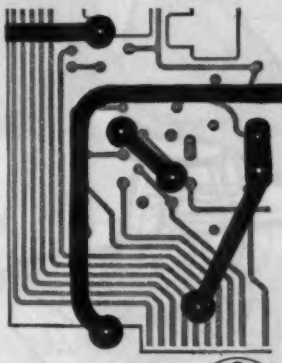

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CIRCLE 211 ON READER SERVICE CARD

STANDARD . . . When there's NO SUBSTITUTE for PRECISION TIMING

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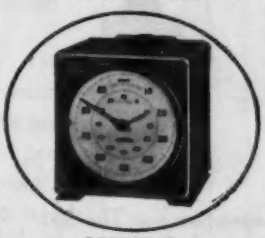

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When the emphasis is on accuracy in timing, the wise choice is STANDARD precision elapsed time indicators. Units are synchronous motor driven . . . electric clutch controlled by manual or automatic switch or output of electronic tubes . . . available with manual or electric zero reset, a-c or d-c clutch.

Model	Scale Divisions	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-300	1/1000 sec.	30 sec.	±.002 sec.

Request Catalog No. 198

THE STANDARD ELECTRIC TIME COMPANY
89 LOGAN STREET, SPRINGFIELD, MASSACHUSETTS

CIRCLE 131 ON READER SERVICE CARD

...now wind 19,000 times!

If you're dedicated to the cause of high resolution, you *could* wind your *own* pots and be sure. Allow yourself plenty of time, though — because the secret's in the number of turns per inch, and the spacing between 'em. Pack those turns right in there *closely* and *accurately*, and you *might* have a pot you'll be proud of!

But if you want to eliminate all bother, but not the high resolution, call on Ace! We've designed and built our own special winding equipment; we use premium, close tolerance resistance wire — and really leave no winding unturned to produce pots with the highest resolution in the industry. All AIA sizes, all mounting styles, specials and standards. So get your resolution the easy way — get Acepots! See your ACErep at once!

Here's highest resolution in a standard sub-miniature pot: The 500 Acepot® ½" size, ±0.3% independent linearity. Special prototype section insures prompt delivery on the Acepot® – ½" to 6", AIA sizes.

ACE ELECTRONICS ASSOCIATES, INC.
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Acepot® Acetrim® Aceset® Aceohm® ®Reg. Appl. for

132 CIRCLE 132 ON READER SERVICE CARD

tremely accurate portable resistive film bolometer wattmeter for measurement of microwave power, in a 1 to 100 mw range, with an accuracy of ±3 percent.

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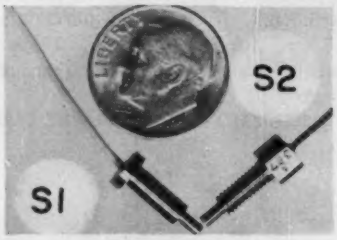

Temperature Sensors two models

ADVANCED TECHNOLOGY LABORATORIES, 369 Whisman Road, Mountain View, Calif. Designed to indicate rapidly changing surface temperatures of steel structures over a wide range of pressures and temperatures, the Delta-Couples are offered with nickel-steel thermocouple junctions at either 0.0002 in. below the surface of interest for maximum response or at 0.002 in. below the surface where abrasion is a consideration. Type S1 was developed to withstand extremely high pressures, such as those experienced in gun chambers, while the threaded body of the model S2 facilitates simple installation. The sensors have successfully experienced repeated transient pressures of 100,000 psi and transient temperatures in excess of 2,100 F.

CIRCLE 334 ON READER SERVICE CARD

Solid State Control for industrial use

TEXAS ELECTRONIC CONTROL SYSTEMS, Houston, Texas. A completely solid state control of supervisory systems is designed for industrial applications such as automation, microwave communication fault alarm systems, and oil and gas

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and in the

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transmission line control and supervision. The solid state principle of construction has no mechanical parts to wear out.

CIRCLE 335 ON READER SERVICE CARD

Time Delay Relay

precision device

WHEATON ENGINEERING CORP., 920 Manchester Road, Wheaton, Ill. The E404 time delay relay weighs only ½ oz and is of crystal can size. Unit is potted in polyurethane foam, which contains CO_2, and is hermetically sealed. It can be mounted in any position. A technical data sheet is available.

CIRCLE 336 ON READER SERVICE CARD

Aluminum Spheres

for semiconductors

SEMI-ALLOYS INC., 550 S. Fulton Ave., Mt. Vernon, N. Y. A new process in the manufacture of tiny aluminum and alloy spheres eliminates contamination inherent in punching and rolling operations by producing virtually perfect spheres with diameters from 0.001 to 0.125 in., within critical tolerances of one ten-thousandth of an inch. The 99.999 percent purity is further maintained by hermetically sealing a single day's production of these spheres in capsules with controlled inert atmosphere offering complete protection against oxidation and an indefinite shelf life. Provision for resealing after partial use further extends product durability.

CIRCLE 337 ON READER SERVICE CARD

Laboratory Power Supply

MODEL 150
features
VARIABLE
FREQUENCY
OUTPUT
380-2400 cps.

With front panel control of feedback for improved load matching, the Model 150 provides 150 volt-amperes for 1.0 to 0.7 leading or lagging power factors. Consuming about 450 watts from a nominal 115-volt 50/60 cycle line source, its output voltage is adjustable from 105 to 125 volts (0-130 volts as a power amplifier). Output voltage regulation is ±2% for load or line as an oscillator (as a power amplifier, regulation is dependent on feedback control setting and power factor of the load).

Total output distortion at full load is about 1.5% at 400 cps. At 50 watts, distortion is less than 1% from 100-500 cps.

Output frequency variation due to rated line and resistive load changes is less than 0.1% ±2 cycles. Frequency variation due to a change of 100 VA of reactive load is about 0.5%.

Cabinet is 21-1/2" wide x 13" high x 15" deep and is equipped with ventilating fan. Front panel is 19" wide x 10-1/2" high and can be mounted on standard relay rack. Net price $575.

For Owners of the RFL Model 829 AC-DC Instrument Calibration Standard

By combining the Model 150 with the Model 829 and the Model 10 Test Equipment Cart, a complete meter calibration facility can be achieved in a small space.

The cart is made of heavy gauge sheet steel and is equipped with free rolling, swivel casters. Usable inside space is 33" wide x 16-1/2" deep x 26" high. One side accommodates standard 19" wide panels to meet RETMA rack standards; the other side has 24" wide opening for equipment mounted in cabinets, such as the Model 150. Interior shelf is adjustable in any position from top to bottom. Accessory, drop-leaf work counter, attachable to either side of the cart, is also available.

Performance is rigidly guaranteed. Price is net, f.o.b. Boonton, N.J. and subject to change without notice.

SEND FOR TECH. DATA

For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

RFL Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U.S.A.

CIRCLE 135 ON READER SERVICE CARD

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Literature of

TRANSISTORIZED POWER SUPPLIES. Mid-Eastern Electronics, Inc., 32 Commerce St., Springfield, N. J. New two-page bulletin describes complete line of transistorized power supplies featuring more than 60 off-the-shelf models including dual output types.

CIRCLE 375 ON READER SERVICE CARD

DIGITAL DATA RECORDING SYSTEM. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. Bulletin No. 350-8 describes a digital data recording system designed for the automatic testing of vacuum tubes on a mass-production basis.

CIRCLE 376 ON READER SERVICE CARD

VIBRATION METER. Southwestern Industrial Electronics Co., 10201 Westheimer, Houston 27, Texas. Model T-1A vibration meter, designed for accurate measurement of the velocity, displacement amplitude and acceleration of vibration, is described and illustrated in a recent bulletin.

CIRCLE 377 ON READER SERVICE CARD

GENERAL PLATE PRODUCTS. Metals & Controls Division of Texas Instruments Inc., 34 Forest St., Attleboro, Mass. A revised brochure describes the scope of the manufacturer's line including solid and clad base metals, solid and clad precious metals, thermostat metals, electrical contacts, and the company's "industrial" metals.

CIRCLE 378 ON READER SERVICE CARD

COAX TRANSMISSION LINES. Prodelin, Inc., 307 Bergen Ave., Kearney, N. J., has available catalog No. 595 showing its entire series 800 rigid copper and rigid aluminum coaxial transmission lines and accessories.

CIRCLE 379 ON READER SERVICE CARD

SUBMINIATURE SERVOMECHANISM. Servo Development Corp., 567 Main St., Westbury, L. I., N. Y. A 16-page brochure describes a kit of precision parts designed to construct model 20-200 subminiature servomechanisms for use in lab-

the Week

oratory, prototype or limited production applications.

CIRCLE 380 ON READER SERVICE CARD

ULTRAMICROWAVE EQUIPMENT. Demornay-Bonardi, 780 S. Arroyo Parkway, Pasadena, Calif. A 12-page brochure illustrates and describes instruments and components for the W size—90 to 140 kmc.

CIRCLE 381 ON READER SERVICE CARD

SILICON TRANSISTORS. Transitron Electronic Corp., 168-182 Albion St., Wakefield, Mass. A two-page reference piece lists descriptions, important data and useful applications of five new silicon transistor developments.

CIRCLE 382 ON READER SERVICE CARD

STRAIN GAGES. N. V. Philips' Gloeilampen-fabrieken, Eindhoven, Nederland, A 49-page brochure gives an extensive description of the technique and applications of strain gages and strain measureing equipment.

CIRCLE 383 ON READER SERVICE CARD

FERRITE ISOLATORS. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y. A recent bulletin describes PRD 1203-1209 ferrite isolators which are specially designed to offer maximum isolation and minimum insertion loss over a frequency range of 3.95 to 26.5 kmc.

CIRCLE 384 ON READER SERVICE CARD

COAXIAL CONNECTORS. Gremar Mfg. Co., Inc., 7 North Wakefield Ave., Wakefield, Mass., has compiled a cross-reference manual to simplify specifying and ordering of r-f coaxial cable connectors and expedite their delivery. For a free copy write on company letterhead.

TIME DELAY RELAYS. Tempo Instrument Inc., P. O. Box 338, Hicksville, N. Y. Bulletin 5903 is an 8-page illustrated catalog containing technical data on a line of time delay relays incorporating the company's no-moving-parts transistor timing module.

CIRCLE 385 ON READER SERVICE CARD

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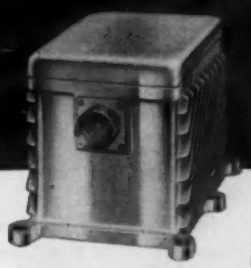

A high degree of efficiency and reliability is assured by the new PESCO Static Inverter developed by BORG-WARNER research. Utilizing controlled rectifiers and **no transistors**, the new unit offers exceptional performance under space flight conditions. **Fewer components** increase reliability. Operation at ambient temperatures of —55°C up to +135°C is possible **without** fans or coolers. **Built-in short circuit protection**, automatic or manual (local or remote) reset, is accomplished without fuses or circuit breakers. Other outstanding characteristics include: Voltage Regulation to ±1%; Frequency Regulation to ±.005%; Inherent sine wave output.

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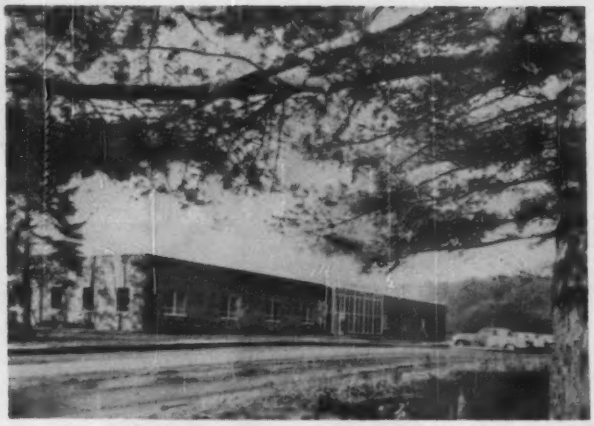
CIRCLE 137 ON READER SERVICE CARD



CGS Labs In New Quarters

CGS LABORATORIES, INC., manufacturer of communications, computing and countermeasures equipment, has moved into newly-constructed quarters in Wilton, Conn., consolidating facilities formerly situated in Stamford and Ridgefield.

The new $500,000 building contains 35,000 sq ft, enough space for the firm to expand to three times its 1959 sales volume. A modern brick, steel and glass structure, the building features recessed fluorescent lighting, year-round air-conditioning, and a floor-to-ceiling glass wall entrance. Sufficient land is available at this site to expand the building to 100,000 sq ft.

Immediate plans call for the development of commercial and consumer items to supplement present government and military business. CGSL is best known in the electronics industry for its TRAK line of advanced communications equipment, including a high-performance antenna multicoupler for the 2-32 mc range and the Increductor controllable inductor, a high-frequency saturable reactor. The firm also manufactures miniature S-band oscillator cavities.

Scott to Head Plant Management

FRED SCOTT, formerly of Kearfott Mfg. Co., has been appointed to the newly created position of general plant manager at Astron Corp., East Newark, N. J.

The post coordinates the many manufacturing functions that have developed from increased sales and facility expansions, according to Irving Black, Astron's executive vice president.

Analab Adds To Staff

APPOINTMENT of Theodore Lasar, Philip G. Schifflin, and Edwin J. Sommers as senior engineers at Analab Instrument Corp., Cedar Grove, N. J., was recently announced by Clee O. Marsh, vice president and chief engineer for the company.

Lasar was formerly a senior engineer with Allen B. DuMont Laboratories. Prior to that he was with the Weston Electrical Corp. and the Bendix Aviation Co.

Schifflin brings to Analab 21 years of experience in the administrative and technical direction of design, fabrication and assembly of a-m and f-m receivers, military and electronic developmental models, telephone test equipment and tv receiver engineering models. His most recent position was with DuMont Laboratories as a research administration coordinator.

Sommers is responsible for the mechanical design engineering at Analab, and most recently was with the Emerson Radio and Phonograph Co. as a senior engineer. Previous experience included four years with the Western Electric Co. and ten years with DuMont Laboratories.

Fairchild Takes Important Post

TO HEAD UP Dynamics Corp. of America's first overseas operation —a newly-created Latin America-Far East division—the company's board has elected John A. Fairchild as corporate vice president in charge of commercial and governmental operations in South and Central America and the Orient.

Former director of U. S. naval aid to Latin America (1953-1955) and IT&T executive (1955-1958), Fairchild for the past two years was area manager for Latin America for the Raytheon Co.

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Raytheon's new 5CU4 "workhorse" rectifier tube will handle a load output of up to 425 ma. This first full-wave cathode type current rectifier is ideal for TV and hi-fi applications requiring up to 300 dc volts. Very low tube drop gives improved regulation and lower transformer costs are possible. Transformer secondary voltage may be reduced approximately 25 volts per plate as compared with conventional rectifiers.

For more information on the 5CU4 rectifier, call your local Raytheon Distributor or write to the Raytheon Company, Receiving Tube Division, Quincy, Massachusetts.

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5CU4 ELECTRICAL CHARACTERISTICS

Ratings*

Heater voltage	5.0 volts
Max. peak inverse plate voltage	800 volts
Max. AC plate voltage per plate	285 volts
Max. DC output current	425 ma
Max. steady-stage peak plate current	1.3 amp
Max. transient peak plate current each plate	6.0 amp
Tube voltage drop (conducting 350ma each plate)	24 volts

*Design maximum values

Typical Operation

(Full wave rectifier with capacitance input)

Heater voltage	5.0 volts
Heater current	3.5 amp
AC plate supply voltage each plate (r.m.s.)	260 volts
Input capacitance	40 mfd
Effective plate supply resistance (each plate)	30 ohms
DC output current	385 ma
DC output voltage at filter input	300 volts

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CIRCLE 139 ON READER SERVICE CARD

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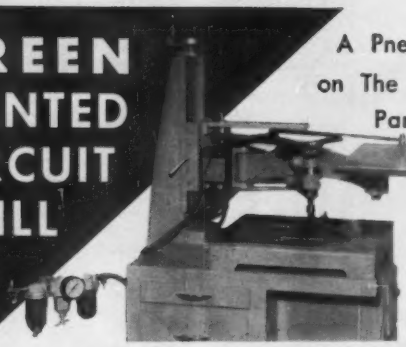

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will handle all Dynamics Corp. of America's electronic products (except home appliances) and plans to establish both sales and manufacturing facilities in key South American centers, as well as the Far East.

Raymond F. Kelley, company president, says the firm "envisages a network of tropospheric scatter long-distance wireless telephone stations, linking all the major cities of South and Central America, and the islands of the Caribbean, in Latin America's first completely dependable and integrated commercial communications system."

Sperry Names Plant Engineer

SAM J. KARNG was recently named department head of plant and industrial engineering at Sperry Semiconductor, So. Norwalk, Conn. This division of Sperry Rand Corp. manufactures silicon diodes and transistors.

For 8 years prior to joining Sperry, Karng was a plant engineer for General Electric Co.

Set Up New Company

AS PART of its expanded program of producing special components for the electronic industry, Accurate Specialties Co., Inc., Woodside, N. Y., has formed a controlled subsidiary called Metalizing Industries, Inc., situated in a 5,000 sq ft facility in Hackensack, N. J.

Metalizing Industries, Inc., will

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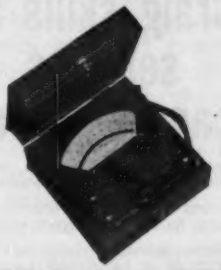

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produce a complete line of metalized ceramic components including metalized solder seal terminals, micromodule wafers, printed circuits, metalized ceramic housings for hermetically sealed resistors, capacitors, transformers, diodes and rectifiers.

News of Reps

Appointment of **Southwest Electronic Industries, Inc.**, Dallas, Texas, and **Zak-Cowen Associates, Inc.**, St. Louis, Mo., as sales reps is announced by Telemeter Magnetics, Inc., Los Angeles, Calif. Southwest Electronic Industries will represent TMI in Texas and New Mexico. Zak-Cowen will carry the company's components lines to southern Illinois, southern Indiana, western Wisconsin, and the states of Iowa, Kansas, Missouri, and Oklahoma.

Communication Accessories Co., Lee's Summit, Mo., adds **Northport Engineering, Inc.**, of St. Paul, Minn., to its list of manufacturer's reps. Territory assigned includes Minnesota, North Dakota, South Dakota, and the state of Wisconsin north of and not including the counties of Crawford, Richland, Sauk, Juneau, Wood, Marathon, Shawano, Brown and Kewaunee.

Pacific northwest sales representation for Cal Chassis will now be **Don Kohler** of Seattle, Wash., according to sales manager H. P. Balderson, of California Chassis Co., Lynwood, Calif. Area will include Oregon, Washington and Idaho.

Digitronics Corp., Albertson, N. Y., announces the appointment of **Components Sales Corp.** of Hartsdale, N. Y., as its rep for the sale of the Dykor high speed perforated tape reader. Territory covered is New York State and the northern half of New Jersey.

S.B.M. Associates, of Rochester and Albany, N. Y., has been appointed sales rep for Shockley Transistor Corp., Palo Alto, Calif., for all of New York State except New York City, Westchester County and Long Island.

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COMMENT

Microminiaturization

In regard to the article "Three Approaches to Microminiaturization," p 49, Dec. 11 '59:

The author's description of type C, under which he identifies Texas Instruments' Semiconductor Solid Circuits, states the components are mounted on one surface of a single wafer. In this approach no discrete nor nondiscrete components are mounted; Semiconductor Solid Circuits are fabricated from a single wafer. By using only a single wafer of semiconductor material, the bonds between dissimilar materials that are encountered in other approaches and conventional components are mainly eliminated. This is a significant feature of Semiconductor Solid Circuits and it is one of the reasons for the potentially improved reliability of these devices.

The primary disadvantage to the type C approach from the author's viewpoint is the temperature and voltage coefficients of semiconductors. Because of these effects, the conclusion is made that linear components cannot be made, limiting these devices to logic type functions. Semiconductor Solid Circuits have the potential to perform many linear circuit functions. It is not inevitable that linear functions cannot be made. The initial development effort was focused on nonlinear functions and, with the successful development of a number of these devices, such as multivibrators, gates, and other logic elements, an intensive investigation of linear functions has begun. This development effort has been most encouraging.

Early in the article, extreme component densities are attributed to semiconductor functional devices, so further emphasis on decreased size would appear to evoke increased interest in this approach. It was puzzling to read the author's "conclusion" that further emphasis on size reduction together with temperature and voltage coefficients of semiconductor material will tend to limit the applications of this approach.

One of the particularly strong features of Semiconductor Solid Circuits is that its fabrication has

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been closely allied to the diffusion process. This highly controllable process has been proven in the past few years by Texas Instruments and other semiconductor manufacturers. Therefore, with the successful design of digital functioning devices accomplished, TI has the experience and background to place them into a proven production process in the near future.

In describing the type B thin-film approach, it is stated that, with the exception of crystals, batteries and chokes, it is now possible to deposit virtually all major components in thin-film form. To the best of our knowledge, semiconductor devices have not been successfully deposited by thin-film techniques.

The reference to transistors being lithographed in this film form on a substrate is inaccurate. Conventional diffused transistor wafers are placed in recesses in the ceramic substrates and only the emitter and base ohmic contacts are made by lithographic techniques. In fact, this statement describes a main deficiency in the type B approach. The semiconductor wafer is not compatible with processes required for the formation of the other components, and an unmounted wafer must be handled separately. In so doing, the proper handling and protection of these wafers is a step that requires more caution and knowledge than is often appreciated . . .

CHARLES H. PHIPPS
TEXAS INSTRUMENTS
DALLAS

From France

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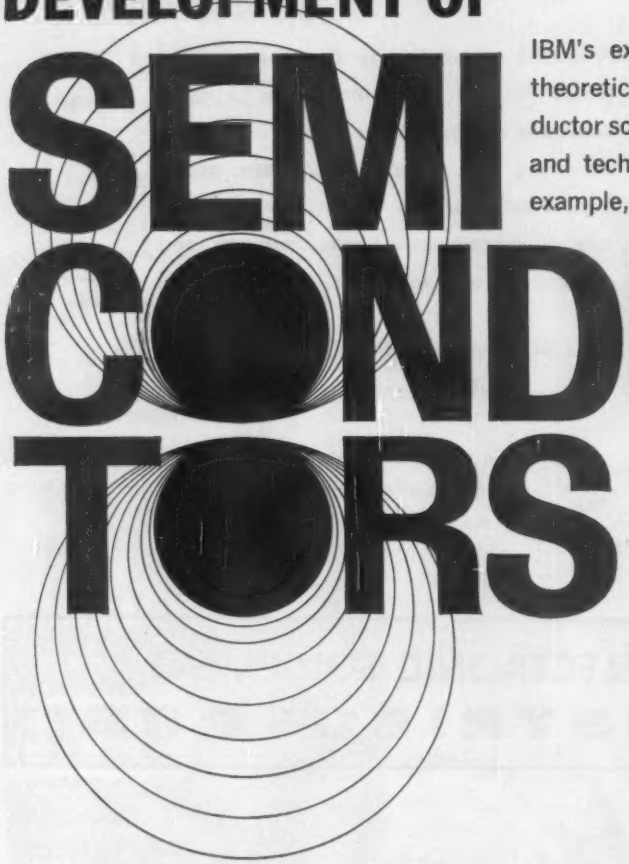
EXPLORE NEW AREAS AT IBM IN RESEARCH AND DEVELOPMENT OF SEMICONDUCTORS



IBM's explorations in the semiconductor field include theoretical and experimental studies in basic semiconductor science as well as development of advanced devices and technologies. In one current research project, for example, a better physical understanding of the origin of the negative resistance characteristic of the Esaki diode is being sought. At the same time, development engineers are exploring applications of this device and have already produced a new solid state oscillator of exceptional simplicity in the 3,000 megacycle range. To date, this represents the deepest incursion into the microwave region via semiconductor electronics. In another project, an NPN double-diffused high-speed drift transistor has been developed that will greatly accelerate logical switching and high-power core driving. Both exploratory investigation and development of these and related electronic devices are expanding at a rapid pace at IBM. To further these programs, well-qualified specialists are required for all areas of device exploration.

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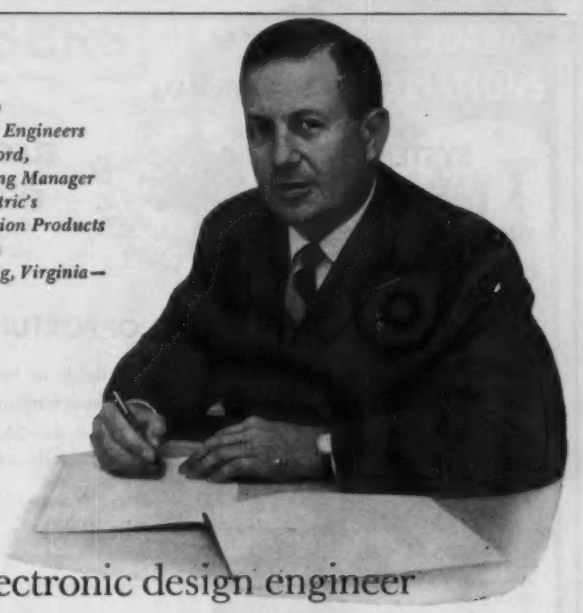

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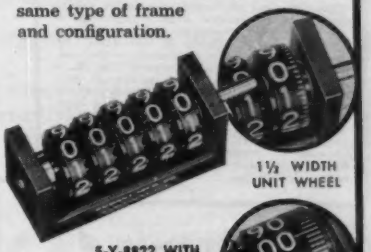

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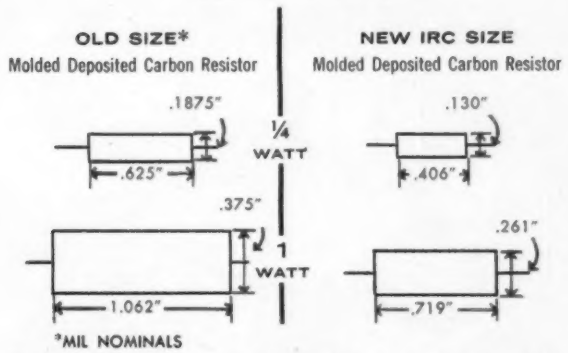

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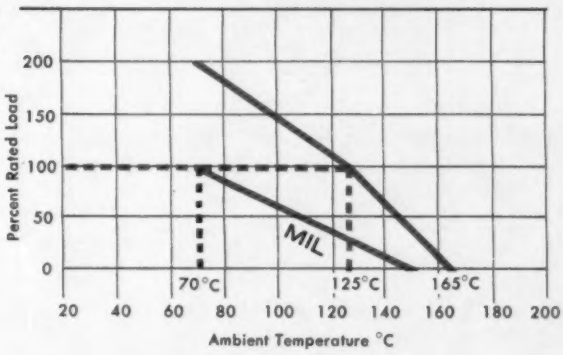

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50 Megacycles (sig. freq.)	**Min.**	**Type**	**Max.**	**Min.**	**Type**	**Max.**	**Min.**	**Type**	**Max.**
Common Base Circuit									
Power Gain (db)	18	21	24	15	18	21	—	—	—
Input Resistance (ohms)	—	25	—	—	30	—	—	—	—
Output Resistance (ohms)	—	8,000	—	—	5,000	—	—	—	—
30 Megacycles									
Common Emitter Circuit									
Power Gain (db)	20	23	26	16	20	24	—	—	—
Input Resistance (ohms)	—	100	—	—	50	—	—	—	—
Output Resistance (ohms)	—	8,000	—	—	5,000	—	—	—	—
12.5 Megacycles									
Common Emitter Circuit									
Power Gain (db)	—	—	—	24	28	32	17	22	27
Input Resistance (ohms)	—	—	—	—	250	—	—	150	—
Output Resistance (ohms)	—	—	—	—	16,000	—	—	4,000	—
1.5 Megacycles									
Common Emitter Circuit									
Power Gain (db)	—	—	—	—	—	—	40	45	50
Input Resistance (ohms)	—	—	—	—	—	—	—	1,350	—
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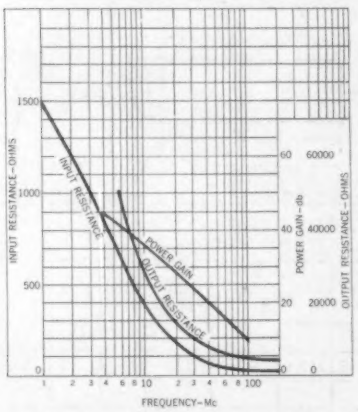

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